PSYCHOLOGY AND PEDAGOGY OF WRITING

Psychology and Pedagogy of Writing

A Resumé of the Researches and Experiments Bearing on the History and Pedagogy of Writing

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CONTENTS.

PREFACE.

Years of practical teaching and supervision, the earnest study of psychology and its application to education, a wide observation of the school work being done by this and other nations, have all been potent forces in convincing me that the reason why practice lags so far behind principles in psychology is that the greater portion of the results obtained by expert, psychological experimenters remains filed away on the research shelves of the libraries of our great universities, unknown and unread by the large mass of educators. Our new psychology is in the nascent or formative stage and the material still remains scattered and unorganized, so much so that only recently has any reliable author undertaken to glean, sift, organize and show the application of the most important principles of psychology to the teaching of the common school subjects. For years teachers have had their brains fairly satiated with method books evolved from the inner consciousness of this or the other author of uncertain psychological caliber.

For convenience all method may be classed as: (1) historical, or doing as has been done before by others; (2) "trial and success," or hitting upon successful ways by numerous trials of different methods of procedure, or following out those discovered by others; and (3) psychological method, based upon the study of children and their near and remote needs. Much of the psychological method may be found in the first two mentioned methods, but it is unknown to the mechanical, unintelligent teacher.

The historical method is the one commonly used by the non-progressive, untrained teacher who is too indifferent or mentally languid to even summon up courage to try something new. If the examples followed in the historical method have been set by a successful teacher, the results of the one copying these may be very satisfactory, but the teaching is in most instances blind imitation and deadening to the future development of the teacher. Even so-called trained teachers graduating from normal schools and colleges use historical methods many times or rather their teaching is saturated, as it were, with the overwhelming personalities and methods of certain teachers. Better far is it for teachers to have the way to the highest source of authority indicated to them, to get perspective, "sky," fundamental principles and inspiration and direction to forge ahead for themselves! Without the scientific attitude toward teaching, it is made to approach the narrowing, mechanical work of the clerk, the factory laborer, the miner.

The wide-awake teacher will use the "trial and success" method and thus advance mentally and professionally, but the experimentation, made blindly many times, involves enormous waste of time, especially where large masses of children are to be advanced. The place for experimental method along psychological lines naturally falls to experimental schools and training departments where the groups are small and the work is supervised or done by thoroughly prepared teachers. Originality is a forceful characteristic, yet it may cause the work of the teacher to become the manipulation of a series of extraneous devices having no psychological foundation.

The advantages, both to the teacher and child, of having methods based on the psychology of the present time and in the future advanced with the new facts of child nature

discovered are so self-evident as to require no explanation. Hence the teacher of today needs to be a student, keeping well abreast with the signs of the times in the psychological world, wide awake and alert to discover and make use of every important result obtained, to be interested in the large questions in education, to keep the psychological perspective cleared of blinding routine and unintelligent method. Psychological truth has been so enlarged and changed during the last decade or two that a teacher who has not kept up with the progress made has inevitably become a Rip Van Winkle in education.

Teachers are not usually willfully negligent of their professional duties; in fact quite otherwise, but the lack of time, heavy responsibility, weariness, lack of opportunity or not knowing what to read causes a lethargy, despoiling them of their psychological attitude of mind and future development as educators.

Of all the common school subjects, writing has been the one most neglected and least understood by teachers. There has been much confusion and fumbling of methods and little effort made to base the principles of teaching upon the laws of psychology. The present work attempts to gather from modern, scientific psychology, and especially from recent investigations in genetic and dynamic psychology, all the principles bearing on handwriting, and to show the application of these to the teaching of writing. Numerous books are to be found upon this, that, or the other system of penmanship, but it remains for the present one to suggest and interest the reader in a larger, deeper, more scientific view of the whole subject of writing and in the new psychology still in the formative stage. It is hoped that this book will in some measure not only acquaint the reader with the results of the scientific study of voluntary movements and the antecedent of such move-

ments but be suggestive for further reading and thinking along other lines.

To the up-to-date psychologist the material presented will not be at all new. For material I wish to thank the authors from whom I borrowed freely and gave due credit; for help and guidance I want to thank Dean Thomas M. Balliet and Dr. Paul Radosavljevich of New York University, School of Pedagogy; for preparation to do the work, my efficient and able teachers in the psychological departments of the Michigan State Normal College, Ypsilanti; the Michigan State University, Ann Arbor; Columbia University, Teachers' College, and New York University, School of Pedagogy, New York City, have my sincere appreciation and thanks; and for giving me inspiration and earnest zeal, I affectionally thank my aged mother in whose sick room the greater part of this book was written, and with whom it is still my privilege to remain.

M. E. T.

Redford, Mich., March 8, 1911.

CHAPTER I

INTRODUCTION.

The Importance of Writing and Recent Interest Shown in the Subject.

Since the desire of communicating ideas seems to be deeply implanted in every human being, it is a question of great moment to study carefully the means of communication. The two most usual modes of gratifying the desire for expression are, (1) by sounds addressed to the ear, and (2) by representations or marks exhibited to the eye; or, in other words, by speech and writing. The first method was rendered much more complete by the invention of the second, because by it was opened a door for the communication of information through the sense of sight as well as by means of hearing. Speech may be thought of as the substance and writing as the shadow which followed it. Speech must be conceded to be the noblest acquisition of mankind, and writing the most useful art. Speech eminently distinguishes man from the brute creation; writing marks the difference between civilized mankind and uncivilized savages. It can readily be understood why this is so, for by writing our thoughts are perpetuated not only for ourselves, but best of all in an extensive, communicative way for the benefit of others. Without the art of writing, the labors of our ancestors, in every branch of knowledge, would have been lost to us, and our own best thought contributions would fail to reach future posterity. The word-of-mouth method of communication gave us tradi-

tion, but not authentic history, as the latter can only be compiled from written material. By means of writing, painting, medals and sculpture all the successive improvements in philosophy, science and the arts have been brought about.

In the common transactions of life, whether for profit or pleasure, intercourse would be very limited without the assistance of writing. By this art distance is, as it were, annihilated and business man, statesman and friend meet in regions the most remote. In these days of rapidly advancing civilization and commercial activity, there are more demands made on the individual to express himself clearly and legibly in writing than ever before. Writing is only a tool of expression, but it is one that must be handled quickly and effectively. The writer needs to have complete command of the art of writing so that his entire attention may be placed upon the thought to be expressed rather than upon the form. In business it is absolutely essential that the mind be freed from all thought of technique of form, as a digression in thought or an ambiguous form may lead to great loss of time or money.

The art of writing is as old as civilization itself; it is thought probable that in North Babylonia the pictograph stage had long been passed eight thousand years ago. We are told that seven thousand years ago in Egypt, Babylonia and Crete both reading and writing were already of hoary antiquity. The written word has always been of mysterious significance to the savage. Among such people, the person who could use symbols for communication was next to the gods; hence written language ministered to forms of worship and remained in the hands of the church. In this way the currency of civilization and learning became written language; consequently the reverenced part of education has not been the sciences as first hand studies of reality,

but language and books have been made the prominent constituents of the curriculum until very recent years.

In our own day the inability to read and write stamps one as an ignoramus. The three R's, Reading, 'Riting 'Rithmetic, that for so many years made up the curriculum of our common schools, show in what high estimation these subjects were held. With the incoming of the idea of universal education after the Reformation, people were taught to read and write in order that they might be able to become intelligent readers of the Bible and other religious literature and be enabled to express their views in permanent form. Arithmetic was added to the curriculum for business purposes. At the present time, along with the multiplication of books and the great commercial pressure brought to bear upon mankind, writing has assumed a new importance. Circumstances and conditions no longer allow a person to write laboriously, slowly and imperfectly, as was the custom in the past, but business and economy of time demand that when one writes it must be at a high rate of speed and as legibly as possible.

Since the child, instead of the subject-matter, has become the center of our educational system, and people have sought to understand the child's physical, intellectual and moral natures instead of judging these from the standpoint of those found in adult life, psychologists have directed their attention to experimental work; this is especially true of the past twenty years or more, before which time little reliable work was done. The study of voluntary movement, the formation of habit, fatigue, cross education, etc., have furnished an unusually attractive field for investigation by psychologists, and as a result much data has been given to the educational world upon which a more scientific pedagogy may be based.

It is with this thought in mind that the present writing has been undertaken. The methods for each important

school study should have a psychological basis and be put in such permanent form that teachers and supervisors of such subjects may be able to read and understand. Far too much of the data of experimental psychology is stowed away in fragmentary, technical form to be referred to by psychologists only; consequently actual practice is changed but little, and the great majority of teachers remain in ignorance of what has been done by psychologists to put education on a more scientific and economical basis. Dr. Huey, speaking of the need of a more scientific basis for each school subject and that the results obtained by experimenting should be put in readable form for teachers, says: "Consider the need of this in the various branches. Not to mention writing, a branch in which there is perhaps the most of needless confusion and in which perhaps the greatest benefit would be derived from such a concentration of data. . . . ." (24, Preface, p. 8.)

In the following chapters it is proposed to trace out the development of the alphabet; to collate some of the best recent investigations bearing on the psychology of writing, and upon these as a basis to formulate and apply the educational principles deduced therefrom. Many experiments have been performed, but the field has in no sense been fully covered, hence it remains for psychologists to carefully carry on further investigations. The principal aims will be to tell what has been done, to collect the fragments, as it were, and after a careful estimation of the reliability and worth of these, to formulate from the results of the experiments taken up some pedagogical principles and show how these explain and suggest improvements in the present practice in penmanship. Such a gathering together of data bearing on the subject of writing has not before been undertaken, and it is with the hope that the following may, in a small way, prove effectual in improving the prevailing practice that the present work has been undertaken.

CHAPTER II

HISTORICAL DEVELOPMENT OF THE ALPHABET.

Theory of the Evolution of Language.

In order to more fully understand and appreciate the development of writing one must go back to the earliest evolution of language itself, the sum and substance of writing. Drummond writes that in order to fully appreciate the development of language we must take our places in the primeval forest with early man and put ourselves in touch with his real experiences and necessities. (14, p. 156.)

Co-operation was one of the earliest principles to be hit upon in the course of evolution. Gregariousness was an established institution long before men had learned to form themselves into tribes and clans for mutual strength and service. The bees in hives, the ants in colonies, the birds in flocks and the wolves in packs are a few of the social types of today that are abundant and dominant in all parts of the world, indicating that the gregarious state has exceptional advantages in the upward struggle.

The most important advantage is the mental strength of a combination and the physical strength of numbers. For instance, every animal in the herd shares the observational powers of all the rest. If one animal hears a sound of danger, then that knowledge is shared in by all the other animals. Thus in helping one another to avert a crisis of danger, the value of this mutual aid is so great that gregarious animals, although many times timid and defence-

less as individuals, have survived in abundant numbers to occupy the highest places in nature.

The co-operative principle depends upon the ability of the members of the herd to communicate with each other. The signalling system if developed by one herd and not by another would give the herd possessing it the greater chance for survival; hence the evolution of the signal system. New circumstances and relations arising called for additions, and vocal, visible, audible came into use. Drummond gives this example: "When a deer throws up its head suddenly, all the other deer throw up their heads. That is a sign. It means 'listen.' If the first deer sees the object which has called its attention to be suspicious, it utters a low note. That is a word. It means 'caution.' If next it sees the object to be not only suspicious, but dangerous, it makes a further use of language-intonation. Instead of the low note 'listen,' it utters a sharp loud cry that means 'run for your life.' Hence these three kinds of language—a sign or gesture, a note or word, an intonation." (14, p. 158.)

EVOLUTION OF WRITING.

Writing has evolved, it is thought, through the same general stages as the evolution of speech. First there was the gesture language, corresponding to the signaling system spoken of in connection with the herd, that was used by primitive man as a means of communicating with his fellows; next there was the onomatopoetic, or growl writing, ideographs, in which forms of actual objects were imitated as in the Egyptian hieroglyphics, the picture of a man was drawn to represent the idea of man, etc. This is the note or word stage found in the evolution of language. Gradually intonation was added—accent—for extra meaning or extra emphasis; this stage in its earlier development is well

illustrated in the Chinese representation of complex ideas, and will be explained later.

"The really important factor in human progress has not been so much the discovery of a method by which words can be recorded as it has been the invention of some facile graphic device, such as the alphabet, by means of which the art of writing can be so far simplified as to become attainable before the years of adolescence have been passed." (41, p. 4). A people may possess the art of writing without the knowledge of an alphabet, but such a system of non-alphabetic writing will either be so limited in its power of expression as to be of little practical value, or else it will be too difficult, complicated and unsuitable for general use. The methods of writing used by the Egyptians, Assyrians and Chinese go to prove that without the alphabet any complete system for the graphic representation of speech is an acquirement so difficult as to demand the labor of a lifetime. Under such conditions, science and religion necessarily tend to remain the exclusive property of a sacerdotal caste; extended national culture becomes impossible. Thus a system of writing instead of being the most effective means of progress may become instead one of the most powerful means of enslaving the masses of mankind. The invention of the alphabet in its present form has proved to be the most difficult enterprise which the human intellect has ever undertaken. In the words of Dr. Taylor: "To achieve the letters as we know them has taxed the intellect of the three most gifted races of the ancient world. It was begun by the Egyptians, continued by the Semites, and finally perfected by the Greeks." (41, p. 4.)

The hieroglyphic writing of the Egyptians, although it is the source of all existing alphabets, is far from being the only graphic system invented or the only one which attained the alphabetic stage of development. Various

races have succeeded in inventing methods of writing entirely independently of one another. The characteristic fact to be remembered is that the starting point and the general direction of development have been the same; i. e., all systems of writing have been found to have had their beginnings in rude pictures of objects; these pictures, becoming conventionalized, more or less gradually came to be used to represent words, and later became the symbols of more or less complex and abstract thoughts.

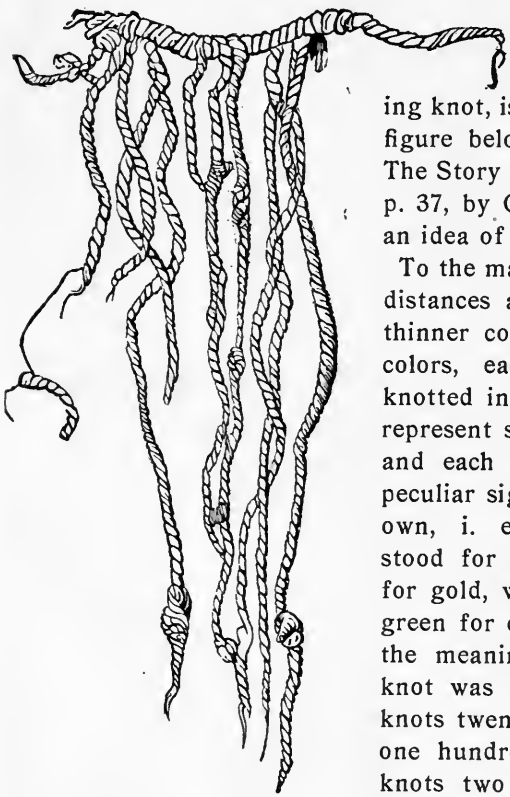
It is now our purpose to inquire into the primitive forms of writing from which all alphabets are the abbreviated descendants, to instance similar stages found among the nations of today, and to show how our own alphabet has reached such a high stage of perfection. After a careful survey of the long period covered by the development of writing, we are enabled, for the sake of convenience and brevity, to arbitrarily divide the whole into three stages:

1. The Mnemonic, or Memory-aiding.
2. Ideograms:
   (1) Pictures of Objects.
   (2) Pictorial Symbols or Words.
3. Phonograms:
   (1) Verbal Signs.
   (2) Syllabic Signs.
   (3) Alphabetic Signs.

1. THE MNEMONIC STAGE.—In this some tangible object is used as a message, or for record, between people living at a distance from each other, and also for the purpose of accrediting the messenger. This stage borders on and anticipates the symbolic stage of expression. Good examples of the mnemonic are the "quipus" or knotted cords, still used by the Puna herdsmen of the Peruvian

plateaux to register their herds, and also by the Paloni Indians of California in business transactions.

The history of the "quipu" is a long one; the idea being still with us in both the rosary upon which the Roman Catholics count their prayers, and in the knot tied in our handkerchief to help our weak memory, as well as in the sailor's log-line. The device was of widespread use, reaching its most elaborate form among the ancient Peruvians, from whose language the term "quipu," meaning knot, is borrowed. The figure below (taken from The Story of the Alphabet, p. 37, by Clodd) will give an idea of the form.



Quipu, for reckoning, &c.

To the main cord at given distances are fastened thinner cords of different colors, each cord being knotted in divers ways to represent special purposes and each color having a peculiar significance of its own, i. e., red strands stood for soldiers, yellow for gold, white for silver, green for corn, etc., while the meaning of a single knot was ten, two single knots twenty, double knot one hundred, two double knots two hundred. Besides being a convenience in reckoning, they were

used for keeping the annals of the empire of the Incas, for sending orders, for preserving records of the dead, as in old Egypt, etc.

At the present time small cords are used by the native tribes of Ardrah in West Africa; while other African tribes have devised message sticks similar to the well-known native Australian type. More highly developed knot-reckoning is found among the Mexican Zuni, and in more primitive form among some of the North American Indians. A generation ago the Hawaiian tax-gatherer kept account of the assessable property throughout the island on cords from four to five hundred fathoms long. The Chinese used knotted cord prior to the invention of writing, and its use is also found depicted in Egyptian hieroglyphics. In 1834 the Houses of Parliament were destroyed through the overheating of stoves burning up an accumulation of tally-sticks that had been used to keep the accounts of persons lending money to the government. In Scotland fifty years ago the baker boy made a notch on his "nick-stick" for every loaf of bread left on his rounds (9, p. 41). Thus it will be seen that the use of objects for recording was almost universal in the distant past and still survives in some measure.

Because of our familiarity with the wampum of the North American Indian, little need be said on the subject. The use of wampum belts is not widespread. The belts consist of hand-made beads or perforated shells arranged in various more or less conventionalized patterns on bark filament, hemp or deerskin strips or sinews, the ends being selvedged by sinews or fibers of hemp. The patterns are usually pictorial symbols recording events in the history of the tribes or treaties between tribes. The Penn belt shown below (taken from Clodd's Story of the Alphabet, p. 46, and preserved in the archives of the Historical Society of Pennsylvania) derives its name from

the tradition that it is the identical belt given probably in 1701 to William Penn by the Iroquois in confirmation of the friendly relations then established between them. The design, as does the average belt of this kind, approaches the ideographic stage of writing and represents two figures, one an Indian grasping a white man's hand (as evidenced by the wearing of a hat). The oblique bands are the symbols of the federation of Iroquois known as the "Five Nations." "The Iroquois league is spoken of in their Book of Rites as Kanastat-sikowa, the great framework. It is this mighty structure which, when the belt in question was given, overshadowed the greater part of North America, that was indicated by the rafters, shown as oblique bands." (21, p. 244.)

Penn wampum.

2. IDEOGRAMS.—These are pictures intended to represent either things or thoughts. They are of two kinds: (1) Pictures, or actual representations of objects, and (2) pictorial symbols suggesting abstract ideas. "The earliest record which we possess of any actual event is the scene depicted on a fragment of an antler, which was found in the rock shelter at Langerie Basse in Auvergne. It portrays a primeval hunter covered with long hair creeping up to a gigantic urus feeding in the grass, and he is seen in the very act of casting a spear at his unsuspecting enemy (23, p. 16). Dr. Hoffman thinks that primitive man, in his attempt to record and transmit graphically his thoughts, selected such objects within his environment as were most frequently encountered in his struggle for existence, i. e., simple representations of animals and birds would be drawn to indicate success in hunting, or, depicted upon some conspicuous rock, notify others that the game

represented by the picture was to be found in that locality (23, p. 1). Clodd writes: "The necessity of identifying personal as well as tribal property, especially in land and live stock, led to the employment of various characters, more or less pictographic, which have their representatives in signaries used in ancient commerce and in manufacturers' trade-marks" (9, p. 46). In the marks used for branding cattle, Prof. Ernst of Caracas believes that he can recognize survivals of Indian writing. The same author states that in tattooing, aside from its symbolic and religious significance marking the connection of the man with his clan-totem or individual-totem and also its decorative purpose, there is also a utilitarian purpose. It is known that certain tribes of the Red Indians tattoo both sexes so that the captured individual may be identified and ransomed in case of war (23, p. 2).

The grave of a chief is indicated by his totem scratched upon a slab; tribal boundaries are marked by stones engraved with the totem of the tribe. The very curious records on the Pictish stones of Scotland; the pictures on the magic drums of the Laplanders; the drawings found on rocks in Australia, Siberia, Peru and Arabia not only show how keenly men of different races have striven to record their thoughts and to leave behind them some lasting memorials of their deeds, but these drawings are also of value in proving the essential similarity of the means used by different people to give effect to their desires.

A further extension of the system of picture writing became possible when it was discovered that complex ideas could be conveyed by combinations of simple ideograms. Thus, in the primitive Chinese writing we find a "wife" is denoted by the combination of the conventionalized pictures of a "woman" and a "broom," and the verb "to love" is expressed by the pictures of a "woman" and a "son."

3. PHONOGRAMS.—The next advancement appeared in the form of rebus, or image writing (designated by Dr. Britton as ikonomatic), in which several objects were combined. The form of conundrum called the rebus is an example of the simplest kind of phonograms. In the rebus the picture of an object is taken to denote any word or part of a word which has the same sound as the name of the thing pictured. It is thought to be true that the reason why children like rebus writing now so much is that at about a certain age they, too, as the race has, pass through this stage of development. If, like the ancient Egyptians, we were to adopt a circle with a central dot as our ordinary written symbol for the sun, then we would have a pure ideogram, but if we were to go on, and, after the Egyptian or Chinese methods, were to use the same symbol to express also the word "son," we should have a phonogram of that primitive type which has repeatedly served to bridge over the gap between picture ideograms and phonetic characters. It is thought probable that the adoption of the important step by which the advance was made from ideograms to phonograms arose out of the necessity of expressing proper names (23, p. 22). The script of the ancient Mexican supplies examples of the change from the pictographic to the phonetic stage. For example, the name of one of the kings was Itzcoatl, or "Knife-Snake," and the name was sometimes written as in the first figure, the stone knives on the back of the snake were known by the name of (itzli), while the snake's name was Coatl. At other times the name was written as shown in the second figure, the first syllable, itz, being represented by a weapon, itz(tli), the lower character, and above this appears, not the

Itzcoatl


Rebus of Itzcoatl.

head of a snake, but instead an earthen pot, co(mitl), surmounted by the sign for water a (tl). The two latter pictures were used to suggest a total sound, the name of the object entirely unlike either pictures (42, p. 94).

Phonograms are the graphic symbols of sounds. As a usual thing they have arisen out of conventionalized ideograms which have been taken to represent sounds instead of things. In the case of Chinese characters we find the most notable instance of a graphic system which has never succeeded in advancing beyond the most rudimentary stage of conventionalized picture writing. Through research it has been found that when the intricate and queer Chinese characters are traced back to their earliest types, they are found to be conventionalized forms descended from rude pictures to which they now bear little or no resemblance, i. e., Kiuen, a "dog," is denoted by the character 犬, and mu, "wood," by 木. These two characters present a much closer resemblance to each other than either of them possess to the object whose name it bears. Yet the difficulty disappears when these characters are traced back to their earliest forms. The character for mu, "wood," was originally written 𣏌 or 𣏌, a form in which the representation of a tree, with its branches, trunk and roots, can be plainly recognized. In the other case we find the character for kiuen, "a dog," takes the form 𤴔, 𤴔, and 𤴔, in which it is not difficult to perceive a rude outline intended for the picture of a dog (41, p. 20). The whole forty thousand words found in the Chinese dictionary are represented by symbols standing for sound-words, phonograms, together with determinatives as keys to the precise meaning to be attached to the phonograms, e. g., the sound pa has eight distinct significations, that is, there are eight different words which are thus pronounced. One of the

phonograms which expresses the sound **pa** is 巴, the original of which 𓆑 is apparently the picture of the tail of some animal. When this phonogram is used in conjunction with the key of plants the symbol denotes a banana tree; with the key of iron it signifies a war-charm; with the key of sickness it means a scar; with the key for mouth it stands for a cry, and so on for the other four meanings which the sound may have (41, pp. 26-27). The Chinese language is a language of roots; it has no terminations to denote number, case, tense, mood or person; the same word, without change of form, may be used as a noun, a verb, an adjective, an adverb or a participle. It is a monosyllabic language, consisting almost entirely of homophones, that is, the same articulation has to do duty for several widely different words, hence the use of "keys," "radicals," or "primitives," as they are called. In the Egyptian and Cuneiform these "keys" are called "determinatives." In the English language one learns which meaning is to be conveyed by the aid of variant spelling, e. g., rite, write, right, wright. In order to be able to write an ordinary business letter in the Chinese language one would have to commit to memory some six or seven thousand of these groups of characters. It has been found that a diligent Chinese student of twenty-five years of age has barely acquired the same amount of facility in reading and writing as that attained by an American child at the age of ten; hence in China and in other countries not possessing an alphabet, few people learn to read and write, and these few are known as the learned caste.

Syllabism, the next stage in the progress of writing, finds its best illustration in the development of the Japanese writing out of the Chinese. About the third century A. D., at the time of the great eastern extension of the Buddhist faith, the Japanese came into contact with the

civilization of China, and obtained a knowledge of the characters in which the Chinese literature was written. The Japanese language was polysyllabic, and the Chinese characters, which are verbal phonograms, could only be used for the expression of the polysyllabic Japanese words by being treated as syllabic signs. A number of characters sufficient to constitute a syllabary having been selected, it was found that the whole apparatus of "keys" might be rejected. Here, however, the development has stopped. It seems strange that a people as ingenious and inventive as the Japanese would not, during the one thousand years that have elapsed since the introduction of the Chinese characters, develop their syllabary into an alphabet. The fact that such a development has not taken place is sufficient to show that the working out of an alphabetic principle of writing is not as easy or obvious a matter as might be supposed. It might be noted in passing that now when the Japanese have come in contact with Western civilization and have discovered how convenient and simple the Roman alphabet is, a movement to substitute it for the native syllabary has sprung up.

Authorities who have made a careful study of the matter have come to the conclusion that there is a general law governing the advance from one stage in the development of writing to the next. A next higher stage is only attained by the transmission of a graphic system from one nation to another. In addition to the example just cited, the transmission of the Aztec hieroglyphics to the Mayas of Yucatan, of the Egyptian hieroglyphics to the Semites, and the thrice-repeated transmission of the Semitic alphabet to Aryan nations—to the Greeks, to the Persians and to the Indians, are facts confirming this general rule. The best example of this general law is found in the case of the repeated transmission of the Cuneiform writing. It was invented by the Accadians, a Turanian people, and

transmitted to the Semitic Assyrians and Babylonians; while out of the Semitic Cuneiform arose on the one hand the Turanian Proto-Medic syllabary, and on the other, the Cuneiform alphabet of the Aryan Persians (41, p. 39).

Alphabetic signs or letters represent the elementary sounds into which the syllables can be resolved. How their development came about will become clear and understandable during the following treatment of the Egyptian hieroglyphics. The earliest extant inscription in the world is a tablet now in the Ashmolean Museum at Oxford, which was erected by Sent, a king of the second dynasty, to the memory of Shera, who appears to have been his grandson. M. Matiette's chronological scheme places the date at about 4700 B. C. This affords conclusive proof that even at that date the hieroglyphic writing was already an extremely ancient graphic system with long ages of previous development stretching out behind it. The Egyptian hieroglyphics, like every other primitive mode of writing, began with picture ideograms, many of which continued to be used to the very last. Abstract ideas which could be directly represented, were expressed by means of symbolic pictures, e. g., battle  , by two arms, one holding a shield and the other a javelin. The next stage of development must have been that the primitive ideographic sign gave place to the verbal phonogram, and then later these verbal phonograms came to be used as syllabic signs; finally these syllabic signs were combined so as to form compound phonograms on the principle of the rebus.

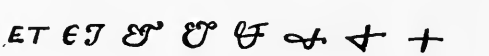
Egyptian writing also contained alphabetic symbols out of which our alphabet has grown. In the inscription of King Sent, three of these alphabetic characters are employed to spell the monarch's name, which reads (41, p. 60). "Two of our English letters, n and d, are derived in strict historical filiation from two of the alphabetic signs,  and  , by means of

which the name of King Sent is expressed. Alphabetic symbols on the Egyptian monuments go to show that the letters of the alphabet are older than the pyramids—older probably than any other existing monument of human civilization, with the possible exception of the signs of the zodiac" (41, p. 61).

The Babylonians, Assyrians, the Medes and the Japanese succeeded only in passing through the syllabic stage, while the oldest hieroglyphic records of the Egyptians had already advanced to the great conception of alphabetic writing. Symbols for vowel sounds are found in the syllabaries of these nations, but the more difficult conception of a consonant was not even approached. The notion of a consonant, a sound that cannot be sounded except in conjunction with some other sound, different from itself, is very difficult; it involves the analysis of the syllable into its ultimate phonetic elements. Canon Taylor states: "All that remained to be done was to take one simple step—boldly to discard all the non-alphabetic elements, at once to sweep away the superfluous lumber" (41, p. 68). This step they never took, but continued to use eye-pictures side by side with that of ear-pictures, instead of advancing to the use of fixed signs for certain sounds (9, p. 115).

Even at the present time we still continue to use phonographic and ideographic signs to a considerable extent. Grotefend claims that several of the Roman numerals are ancient ideograms. I, II, III, may be regarded as pictures of fingers, and it is probable that V was at first a picture of the fork of the hand, the fingers collected and the thumb apart, so that VV or X represents the two hands, while IV and VI would be a picture of the hand with the subtraction or addition of a finger. In technical writing such terms as T-square and S-hook and phrases such as "$\odot$ before clock 4 minutes," and "$\supset$ rises at 8 h. 30 min.,"

survive to show that even in the midst of the highest European civilization the spirit of the earliest and rudest form of writing is not yet quite extinct. The zodiacal and planetary signs used by astronomers are also ideograms, e. g., the symbol ☿ is the caduceus of Mercury entwined by two serpents, ♀ is the mirror of Venus with its handle, and ♂ is the shield and spear of Mars. Other ideograms used by us are the crown and the broad arrow, sundry trade marks and armorial bearings, together with several printers' signs, such as ☞, ! and =. Certain shop signs, such as the barbers' pole with its spiral bandages, which is a significant ideogram of the blood letter; the three golden balls of our pawnbrokers is a curious survival of the boluses which denoted the ancestral calling of the Florentine family of the Medici. In £. s. d. we have characters of alphabetic origin used simply as convenient phonograms standing for the words "pounds," "shillings" and "pence." &c., ?, $, lbs., cwt. belong to the same class. Most of the Arabic numerals are degraded forms of Semitic letters; while the successive forms of



show that the algebraical sign + is a contraction of the Latin word et, as — is of minus (41, p. 81).

ORIGIN OF THE ALPHABET.

The immediate parentage of our English alphabet is not difficult to determine, as our Roman capitals are practically identical with letters employed at Rome in the third century B. C., such as are seen in the well-known inscriptions on the tombs of Scipios. It has been found that the primitive alphabet of Rome was derived from a local form of the Greek alphabet prevailing in Bœotia and Eubœa

about the sixth century B. C. This Eubœan alphabet is thought to have been introduced into Italy by means of colonies from Chalcis which were established in Sicily and also in central Italy at Cumae and Neapolis. The Chalcidian alphabet was a variety of the archaic alphabet of Greece, judging from the numerous inscriptions, the earliest of which may probably belong to the eighth or ninth century B. C.

The classical writers agree in attributing the invention of letters to the Phœnician, from whose trading posts in the Ægean they were obtained by the Greeks. Herodotus says: "The Phœnicians introduced into Greece the knowledge of letters, of which, as it seems to me, the Greeks had heretofore been ignorant" (41, pp. 70-74).

An examinataion of the alphabet, however, gives evidence through the names, number, order and form that they are of Semitic origin. The very word alphabet is derived from the names of the two letters alpha and beta, which stand at the head of the Greek alphabet and which are plainly identical with the names aleph and beth borne by the corresponding Semitic characters. In Greek these names mean nothing, but they are significant Semitic words, aleph denoting an "ox," and beth a "house" (41, p. 75). By some authorities, as Taylor, the Semitic alphabet is considered the source from which all existing alphabets have been derived.

Down to a very recent time the classical tradition was very generally discarded, and the origin of the alphabet was thought to be by the highest authorities an unsolved problem. Now scholars seem to agree not only as to the source of the Semitic alphabet, but also as to the special place, mode and period in which it must have originated. A French Egyptologist, Emanuel de Rouge, in 1859, was the first to formulate a theory of the origin of the alpha-

bet. M. de Rouge refers the origination of the Semitic alphabet to the period of five or six centuries during which a race of Semitic kings ruled in Delta. His method of investigation began by determining the oldest known forms of the Semitic letters. For comparison with these he selected such of the Egyptian hieratic characters as were used at the time the Semitic people occupied Delta, and as a result he found that the primitive form of almost every Semitic letter can be easily and naturally deduced from the form of its normal hieratic prototype. It is said that the secret of his success in solving the problem lay in the fact that he sought for the immediate prototype of the Semitic letters not in the Egyptian hieroglyphics, as many before him had done, but among the cursive characters which the Egyptians had developed out of their hieroglyphics and which were employed for literary and business purposes (41, p. 88). The origin of the alphabet has been placed in time as being between the 23d and 17th centuries, possibly the 19th century, says de Rouge.

Recent investigations, particularly the excavations in Crete, reported by Sir Arthur Evans (15, pp. 270-372), seem to establish the fact that Greece is far older than has been thought, and that a flourishing civilization existed in the Ægean at least as early as 3000 B. C., with centers in Crete and probably later in Mycenæ; also that there was close intercourse between this civilization and that of Egypt about 2500 B. C. The Ægean script, according to these investigations, seems to have been in use long before Phœnicia existed, and as Phœnician history only goes back to about 1600 B. C., Phœnicia's chance for commercial importance seems only to have come with the fall of Mycenæn civilization.

However this may be, we know that Phœnicia was dominant in the Mediterranean, and probably took, for business

purposes, the alphabet material that was to be found and gave to it a more practical form. No one can perhaps judge just how much was taken from the cursive writing of the Egyptians or how much was obtained from other sources, yet we are sure that it is possible to trace the

		EGYPTIAN	PHŒNICIAN	GREEK				LATIN			HEBREW
1	Eagle				A	A		a	A	A		א
2	Crane					B				B		ב
3	Throne									C		ג
4	Hand									D		ד
5	Mæander					E				E		ה
6	Cerastes									F		ו
7	Duck									Z		ז
8	Sieve					H	H			H		ח
9	Tongs											ט
10	Parallels								I	I	i j	י
11	Bowl					K			K	K	k	כ
12	Lioness								L	L	l l	ל
13	Owl									M		מ
14	Water									N	n n	נ
15	Chair-back									+	x x	ס
16	....											ע
17	Shutter									P	p	פ
18	Snake											צ
19	Angle									Q	q q	ק
20	Mouth									R		ר
21	Inundated Garden									S		ש
22	Lasso									T	t	ת
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI

actual pictorial origin of some of the characters of the alphabet to the Egyptian, i. e., the Egyptian hieroglyphic owl, mulak, becomes the sign for its initial letter m, and later is conventionalized more and more until the present form is reached, as is shown in the table (9, p. 130).

The fact is established that the Phœnicians, who were of the Semitic race, were full of commercial activity, and when they came among the Hellenes, they brought with them their collected system of abbreviated alphabetic characters. To these the Greeks added still other characters and modified those introduced. The table on page 34 shows the names and order of the Greek and Semitic letters, the Hebrew being selected as the type of a Semitic alphabet most familiar at the present time (41, p. 75).

LATIN ALPHABET.—This is by far the most important of all the alphabets derived from the Chalcidian type of the Hellenic, as explained before. The date of introduction of the Greek alphabet into Italy has been established as being about the eighth century B. C. The ultimate dominance of the Latins brought about the abolition of every other alphabet except their own, which, becoming the alphabet of the Roman Empire, and then of Christendom, secured an everlasting supremacy. Through it the Greek and Roman culture was conveyed to Western Europe, and it is now the vehicle of all the culture of the progressive races of the world. In all the essentials the Latin alphabet is identical with the Greek, yet it took its own line. "The earliest Indo-European or 'Aryan' language contained, so far as can be discovered, twelve consonants and three vowels (i, a, u), and to these the Latin added e and o. It at first rejected the Greek K, and used C for the sounds of both k and g, but later on added a bar to the lower end of C, converting it into G. Similarly, R is but a variation of P, by the addition of a stroke below

THE HEBREW ALPHABET.					The Primitive Order.	THE GREEK ALPHABET.			
Numerical Values.	Phonetic Values.	Forms.	Names.	Meanings.		Forms.	Names.	Phonetic Values.	Numerical Values.
1	*'a*	א	Aleph	ox	I	*α*	Alpha	*a*	1
2	*b*	ב	Beth	house	II	*β*	Beta	*b*	2
3	*g*	ג	Gimel	camel	III	*γ*	Gamma	*g*	3
4	*d*	ד	Daleth	door	IV	*δ*	Delta	*d*	4
5	*h*	ה	He	window	V	*ε*	E-psilon	*ĕ*	5
6	*v*	ו	Vau,	hook	VI	*ϝ*	Vau	caret	6
7	*z*	ז	Zayin	weapons	VII	*ζ*	[Zeta]	*z*	7
8	*ch*	ח	Cheth	fence	VIII	*η*	Eta	*ē*	8
9	*ṭ*	ט	Teth	serpent?	IX	*θ*	Theta	*th*	9
10	*y*	י	Yod	hand	X	*ι*	Iota	*i*	10
20	*k*	כ	Kaph	palm of hand	XI	*κ*	Kappa	*k*	20
30	*l*	ל	Lamed	ox-goad	XII	*λ*	Lambda	*l*	30
40	*m*	מ	Mem	waters	XIII	*μ*	Mu	*m*	40
50	*n*	נ	Nun	fish	XIV	*ν*	Nu	*n*	50
60	*s*	ס	Samekh	post	XV	*ξ*	[Xi]	*x*	60
70	*'a*	ע	'Ayin	eye	XVI	*ο*	O-micron	*o*	70
80	*p*	פ	Pe	mouth	XVII	*π*	Pi	*p*	80
90	*ts*	צ	Tsade	javelin?	XVIII	*ϡ*	[San]	caret	900
100	*q*	ק	Qoph	knot?	XIX	*ϟ*	Koppa	caret	90
200	*r*	ר	Resh	head	XX	*ρ*	Rho	*r*	100
300	*sh*	ש	Shin	teeth	XXI	*σ*	[Sigma]	*s*	200
400	*t*	ת	Tau	mark	XXII	*τ*	Tau	*t*	300

the crook. And while the later Greek rejected Q, the Latin retained it" (9, pp. 195-6).

The Romans used two sorts of characters, capitals and cursive, in the early empire. The capitals were square-shaped, and were used for inscriptions and other writing demanding prominence, as we use capitals now, borrowing the old Roman forms. The cursive or running characters are the originals of our small types, and were used for correspondence and other purposes where rapid writing was the object.

Both Y and Z were late importations from the Greek into the Latin, being previously used only in Greek loan-words to denote sounds peculiar to the Greek; hence because of their late introduction they were placed at the end of the alphabet.

Some of our letters are of no more use to us than they were to the Romans, i. e., Q and X, and K makes C superfluous. As a consequence we have only twenty-three letters to represent at least thirty-two sounds. Thus we see that our alphabet, like our spelling, which is at war with our pronunciation to the bewilderment of school children and foreigners, is what it is because of the lack of any consistent rule (9, p. 200).

A word may be added as to the direction of writing, and how it came to be from left to right, as we have it now. It has been found by investigation of the Moabite Stone, discovered in 1868 by Dr. Klein during his travels in Moab, that the Semitics wrote from right to left. After the alphabetic characters were brought into Greece the direction of the writing was modified, and among the Athenians it took the serpentine form, running around the material written upon. Later the plough-wise writing, proceeding alternately from right to left and from left to right—just as oxen when ploughing draw the alternate

furrows in opposite directions—came to be the prevailing one. Finally, the more convenient habitude prevailed, all the lines being written from left to right. The change of direction was plainly effected by a process of very gradual development, and must have occupied a lengthened period of time.

This historical treatment has only been intended to be suggestive of the general method in which our alphabet developed, and to give a general insight into the stages through which any alphabet must pass before it can reach its highest state of perfection.

CHAPTER III.

RÉSUMÉ OF THE EXPERIMENTS BEARING ON THE PSYCHOLOGY OF WRITING.

Analysis of the subject

(1) NEUROLOGICAL ANALYSIS.

ANTECEDENT OF VOLUNTARY MOVEMENT.—In order to clearly understand voluntary movement one must go back to a study of the nervous system itself. The whole nervous system is usually divided into (a) the fundamental portion, or that which man possesses in common with lower animals and which is well developed in the child at birth, and (b) the accessory part or that part which has been superadded during the course of evolution. This new part differentiates the nervous system of man from that of the highest of the lower animals, and it is either not present in the human embryo or exists only in an embryonic condition. Man has acquired erect posture, movements of the hands as organs of prehension, movements of the voice and articulation, facial expression, etc. (39, p. 1). All complex movements are acquired considerably after birth. Ross, about 1880, was the first person to distinguish the parts of the nervous system by use of the terms fundamental and accessory (37, p. 21). The more fundamental and older racial movements appear before the newer and less fundamental regardless of the order of complexity, except in so far as the accessory as a rule tend to be more complex than the fundamental (8, p. 39).

Flechsig's investigations have shown that the fibers connected with the centers that control reflexly the fundamental movements are medullated before birth, while on the other hand fibers connected with the higher centers are not medullated (16, p. 113). It is generally accepted that when a nerve fiber acquires its fatty sheath or becomes medullated, it is then functionally mature; the sheath serving about the same purpose as the rubber covering does to the electric wire it surrounds—prevents wasteful radiation of the nerve current.

One of the conditions emphasized by modern psychology as a requisite for active attention is preparedness, or muscular tension. The present most generally accepted theory of the control of the muscles was presented by Dr. Hughlings Jackson, in about 1872, and is known as the Three-Level-Theory of the nervous system (39, p. 3). The lowest level consists of the nerve cells of the spinal cord, medulla and pons; the movements on this level would be such vital movements as those pertaining to the circulation of the blood, respiration, digestion, crying, etc. The grasping acts of infants immediately after birth, such as hanging on to a rod or finger and supporting the weight of the body, belong to this level. Although the child at birth can grasp a rod and support itself, yet it has no control over such movement and usually loses this power after a few days. "This sensori-motor apparatus is perfectly organized before birth and the sensori-motor action is typically automatic (39, p. 5).

The middle level includes the basal ganglia of the brain, and also the sensory centers of hearing, sight, and the other special sense ganglia. Impressions from the periphery are not sent directly to these centers, but through the ganglia of the lowest level, and the movements controlled by these centers are controlled through the centers of the

lowest level. Grasping an object, removing an offensively smelling object, and such other movements as higher animals, some imbeciles, and young normal children perform without much thought, are examples of movements of this middle level.

The highest level claimed hypothetically the remaining portion of the brain. Control is exercised over each part of the body by each level and each level is both sensory and motor; consequently the motor areas in the brain must have sensory cell elements and the highest centers must have motor elements (39, p. 6). It has been found that the most simple nervous arrangements, centers, and levels are the most organized, while the most complex is the least organized. It is well that this is so, for if the centers of the highest level were highly organized, there could be little modification effected, and as a result few acquirements could be made or adaptations to new circumstances brought about.

A study of the ascent in the hierarchy of control shows that the movements become gradually more complex, more definitely under control, more fully co-ordinated and integrated, thus following the lines of evolutionary development; in other words, the same muscles are controlled by these three different levels. For example, the new-born babe seems to use just the same muscle to grasp the pencil reflexly as does the child of six months when he grasps the pencil to pull it towards himself, and as you would do should you grasp your pencil voluntarily. With many other movements it is the same; that is, after their appearance in reflex use, if they advance beyond this stage, they can only become compounded or rather complexed.

By investigations carried on by Mosso (34, p. 383), it was found that the nerve fibers necessary to the control of movement by the higher centers are not medullated at

birth; while Flechsig (16, p. 123) found that the direction of growth of medullation was not from the highest cerebral centers toward the periphery, but rather, through the mediation of the medulla, in the opposite direction. This naturally leads to the conclusion that the development of these higher centers comes through the movements in the periphery, and consequently that "we move voluntarily not because we think, but rather we are led to think volitionally because we have moved (39, p. 107). In the words of Dr. Mosso: "In man the brain develops later than in all other animals because his muscles also develop later" (34, p. 383).

Movement, it is believed, produces development of nervous substance. An experiment showing the development of the center from the periphery was tried in which an idiot's hand was trained. The experiment was carried out to determine whether the cortical centers for more proximal joints, such as the shoulder in contrast to the elbow, tend to relatively speedy organization, and hence become in some degree a thoroughfare for impulses controlling more distant groups (12, p. 547). The teacher began the training of the idiot's hand from the shoulder by movements which starting from the elevators of the arms would involve successively the muscles of the arm and hand. By a series of such operations, whose willed or obedient starting point descended gradually from the spine, the child became capable of moving his hand and fingers, first by imitation and later for simple willed operations.

Other experiments have been tried to show that the excitation of the senses and impulses to movement hasten the development of the nerves that are implicated. Held, Ambronn and others tried the experiment of opening one eye of a new-born kitten, and found that the optical fibers

of the eye stimulated by the light was more quickly surrounded with myelin than those of the other. In some cases this caused soreness of the eyes opened, but as none of the animals experimented upon were allowed to live afterwards, it is impossible to draw any meaningful conclusion as to what would have been the permanent result of the excitation and forced development upon the general health of the eyes opened (34, p. 384).

In the case of the new-born child the movements are nearly all fundamental; reflex, automatic, instinctive, and random. After a while, when he gets to be perhaps three months old, he responds to sight, sound, etc., the movements being controlled more fully by the centers of the middle level. By the time he is a year old, or before, he sometimes acts with volition and seems to decide what he will do. Chronologically movement seems to advance from the fundamental towards the accessory, and yet the lowest level constantly controls many actions of the child. For example, the child does not need to think of how to take a step after the learning process is over and has been perfected by practice. The reason is that the accessory movements used in walking have gradually changed from accessory control of the highest level to that of the middle and toward that of the lowest, consequently many of the walking movements have come under the control of the spinal cord. In the same way the movement used in writing should pass from the control of the highest level to that of the lowest.

"Devolution."—In old age or general paralysis the higher centers are attacked first, and a person is not able to execute the delicate, finer movements. "As old age increases and disease spreads downward, these more general, more complex, more precise movements pass away, layer by layer, as it were, going from the accessory to the fundamental, from the peripheral to central, from the product

of latest evolution to those of oldest" (39, p. 108). For example, the art of writing is lost before the appreciable loss of the fundamental movements of the hand.

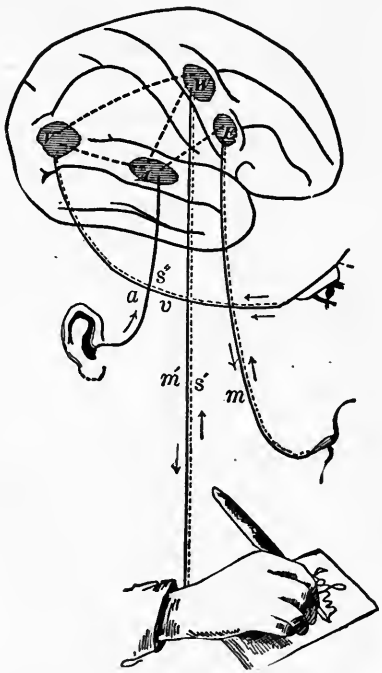
BRAIN AREAS.—It is known that certain of the cortical areas are functionally connected with sense organs from which they receive stimuli, i. e., there is a region or area in the brain receiving auditory impressions, another receiving visual impressions, an area for the reception of olfactory stimuli, one probably concerned with the receiving of tactual, thermal, kinaesthetic and organic stimuli. Thus when one writes, the motor cells make the hand move, and the sensory area sends back the kinaesthetic impressions to the brain. There is reason for the belief that the peripheral sensory neurones are in connection mainly with the opposite side of the cortex from which they originate; the optic nerve, however, is a curious modification of this plan.

A great group of cortical cells known as the region of Rolando from its proximity to the Rolando fissure is recognized as having control over the voluntary muscles. The Rolandic region governs almost all the important movements of the body which are executed by muscles controlling regions for which the skin furnishes the sense organs, i. e., the arms, hands, body, legs and face.

"Besides this there are other large areas in the cortex which are not in immediate control of muscles, nor do they seem to represent the emergence point for neurones in connection with the sense organs" (1, p. 46). Flechsig, the most careful student of these, has named them association centers. They serve to unite the several sensory regions, such as the auditory and visual areas, with one another and with the motor region.

There is another extremely important connection known as the corpus callosum made up of cortical neurones and

joining the two hemispheres of the brain. Thus it is possible for a cortical nervous impulse, originating in the stimulation of some sense organ like the ear, to pass into other cortical regions, as that of vision, and thence out through the Rolandic zone to some muscle. This is what would occur if a person were told to write John. The person would hear the word, think how the word looked, and finally make the movement with the hand to write John (1, p. 47). See diagram below, which is reproduced from James' *Psychology,* by permission of Henry Holt & Company, New York.



A—Auditory center. W—Writing center.
V—Visual center. E—Speech center.

APHASIA.—We already know that each particular form of sensation is located in a special system. It has been found that if these special systems are destroyed, all traces of the corresponding sensations would disappear, and all renewal of the same would be stopped. Also that if the connection between the normal stimulus and the periphery of such a system is destroyed, then physical images essential for the renewal of the sensation are impossible, but the psychical images stored up in the mind persist. On the other hand, the destroying of the determinate regions of the cortex, which are the culminating points of these special systems, will permit of a renewal of the stimulus at the periphery of such a system, but renders impossible the formation of psychical images essential for the renewal of the sensation. (33, p. 661.)

Images are of two kinds—concrete, or images of objects, and symbolical or abstract, or verbal images, as those of language, whether spoken or written. Pathology demonstrates that some of these images may disappear, while others remain. The disappearance may concern the sensations or images of a given sense, and yet allow of the subsistence of other senses; formation choice may also be made between the more or less complicated orders of the different images or representations of this sense. For example, the verbal images of hearing or of vision may be suppressed, and yet the images of objects may persist. All the psychical images may be suppressed and only sensations remain, or the psychical manifestations of a sense may be so utterly destroyed that nothing remains.

A person suffering from aphasia has not lost the whole function of language, but only one of the factors taking part in the complex process. The lesion leading to aphasia presents distinct anatomical and functional forms, for example, in the cortex itself, the partial systems which give

rise to verbal images (cortical aphasias) may be destroyed, or the communication of these systems with each other or with the inferior systems receiving the sensations or for the performance of movements may be interrupted. (33, p. 662). "Even in the brain we distinguish between systems for the reception and organization of sensations and those for the performance of motor verbal function; whence, according to the seat of the lesion in one or the other system, we find two functionally different forms of aphasia, one sensorial and the other motor." (33, p. 663.)

Aphasia led psychologists to investigate the causes, and in so doing the special centers were discovered. Motor aphasia was investigated first. Broca, in 1861, proved that the destruction of the third frontal convolution of the left hemisphere lead to the loss of articulate speech; the motor memory of the articulation of words would be gone. In 1874 Wernicke discovered a word hearing center in the rear part of the auditory area. A new form of aphasia was discovered by him and called sensorial aphasia. A person so affected can articulate sounds or write, but his words have no meaning for him. "Sometimes he has lost his verbal auditory images (word deafness); sometimes he has lost his verbal visual images (word blindness), and the disturbance of the function of language is rendered manifest by his inability to read. The written signs have, for him, lost their symbolical significance; he can write, but cannot read what he has written; he can speak and answer an oral question, but not a written one." (33, p. 664. Thus it will be seen that alexia, or inability to read, does not involve agraphia or inability to write. Dr. Baldwin says: "In these cases we have the extreme motor type of verbal memory; also emphasized by Stricker: persons who remember written words by the memory of the sensations involved in writing them." (3, p. 98.)

WRITING CENTER.—Specialized reading and writing centers have been located. The reading center is made up of specialized cells forming part of the language center, and in right-handed people this center is more fully developed in the left half of the brain. The idea of a separate graphic-motor or writing center was first put forth, in 1881, by Exner of Vienna, and has been advocated strongly by such educators as Mills of Philadelphia, etc., and, in fact, is generally acknowledged by neurologists, although Collins and others disclaim it strongly. It is located in the motor area just in front of the fissure of Rolando, and above and back of the speech area; or, in other words, at the base of the left second frontal convolution. In this area Exner believed the motor memories of writing were stored, the destruction of which area caused agraphia.

Collins (10, p. 62) claims that internal speech is dependent upon a revival of auditory, visual and articulatory memories; all three centers contributing, but the one which is most highly cultivated is revived most vividly. The faculty of writing is developed, like that of articulate speech, under the stress of the impulse of imitation, and the co-ordination, Collins claims, is between the visual center and that part of the motor cortex from which impulses start to move the member that holds the pen, whether it be the hand or any other mobile part of the body. These movements of writing are all accompanied by the reception of kinæsthetic impulses that go to the somæsthetic area of the brain, and the renewal of these memories makes writing seem in those who have had long practice almost like an automatic act. In his estimation the motor act of wielding a brush in painting or in portraying visual sensory images, whether imaginary or real, is done by a cortical area quite as specialized as that for writing. If an idea is to be expressed in articulate speech, impulses are

sent to that area of the Rolandic region of the brain in which there is a separate allocation for the movements of respiration, vocalization, lingual and labial action. This area is adjacent to the area in which are stored sensory memories of articulatory movements. When the idea is externalized in writing, the genesis of the symbol is exactly analogous to that of articulate speech. The spoken word and the written word are both the result of internal language, as nearly everyone cannot help but be cognizant of the words ringing within while writing. They both require absolute integrity of the zone of language, the only difference being that in the first instance the finished product is sent to the cortical area, center of the articulo-vocal musculature, and in the other to the Rolandic allocation of a much less complex motor mechanism, namely, to the cortical center of the member that holds the pen, whatever mobile part of the body that may be. Collins states that practice does not contribute to the development of a special center and that the scrivener does not possess a special center in which are located the graphic motor memories any more than does the telegrapher a telegraphic center, or the typewriter a typewriting center, or the pianist a special center in which are represented the complex movements of the fingers.

Collins attempts to prove that Exner's interpretations of the cases of aphasia examined were wrong, but it must be remembered that Collins undoubtedly is a special pleader for his own belief. Notwithstanding, he brings forth some good evidence and gives about all the proof available against a writing center. For instance, if there is a specialized writing center in the brain in which are stored graphic images of words, then the destruction of this center must entail complete agraphia for both hands and any other part of the body capable of holding a pen.

If this is not so, then ambidextrous persons must have a separate graphic motor center on each side of the brain. This does not seem to be in accordance with what we know definitely of the cortical localization of speech functions (10, p. 143). Collins also claims that no ideal case to prove that there is a graphic motor center has ever been found.

According to the theory of Charcot, the articulatory motor centers and the graphic motor centers are loci in which are stored the motor memories of articulation and the motor memories that guide the hand in writing. He fixed the one for graphic motor images in the foot of the second frontal convolution, and that for articulatory motor images in the foot of the third frontal. Charcot claimed that a lesion that destroys the third frontal does not entail agraphia. The coexistence of motor agraphia with motor aphasia, he claimed, was not necessary, and since then his pupils, Marie, Pitres, Grasset, Brissand and others claim the same and contend that there are cases of pure motor agraphia without aphasia.

Marie (29, p. 241) does not believe that the third left frontal convolution of the brain plays any part in the function of language. Prof. Pierre Marie, a la Faculte de Medicine de Paris, has studied the subject of aphasia, first hand, for over ten years, and if a reader wishes to know more of his investigations, as well as what has been done in the working out of the subject of aphasia by others, an article by Fernand Bernheim (Ancien interne des hopitaux de Paris), entitled "Evolution of the Problem of the Aphasias," published in "L' Annee Psychologique," Vol. 13, 1907, XXI, p. 344, should be read.

As far as education is concerned, it matters little whether or not a writing center can be accurately located, for if there is no such center, then associations are made with the motor area, but we will assume that such a center has been

established as it is most generally accepted by neurologists. The influence resulting from heredity affects the reading and writing centers but little, as they are of such comparatively recent origin as contrasted with the auditory and visual areas; hence the education of these areas may be controlled to a large extent by practice.

COMPLEXITY OF THE WRITING MOVEMENT.—The act of writing is a very complex muscular movement involving the use of some five hundred or more muscles altogether, some authorities state. Passing by, for the present, the origin of writing, and the close analysis and memory for form involved in the learning process, we will here consider the complexity of the muscular act.

There is the movement across the page, bringing into play the large muscles of the arm and movement in the shoulder-joint and elbow. These lateral movements across the paper are different in character and in the muscles employed from the rotary movements used in forming the letters, i. e., the finer finger movements, bringing into play the smaller muscles, usually form the pen-strokes (26, p. 187). These different factors involved in the writing movement must work in perfect harmony in order to be able to do the most effective work; that is, the arm muscles must contract at just the right moment to carry the hand along and yet not interfere with the finer movements. This difficult co-ordination of muscles can only be brought about by long and correct practice as will be acknowledged if one only observes the halting, shifting movements of one just learning to write.

DIFFUSION.—Developed writing movements depend on the existence of a group of brain cells which are interconnected and interrelated in a very complex manner. This growth of interconnections between the cells is the result of a process requiring time and practice. When a young

child begins to learn to write, each brain cell acts in a large measure apart from every other brain cell, and there is no organized co-operation or muscular co-ordination. The child's unorganized movements are called diffuse movements, that is, they are untrained movements which are too much spread out. The real seat of diffusion is not in the muscles, but in the nervous system, where the impulse has been spread out or diffused rather than carried along definite fixed channels. This diffusion of impulses in the child's brain is due to the fact that the brain mass itself is unorganized, the regular lines of connection necessary for co-ordination have not been laid out, hence the impulse is at liberty to wander around, as it were, and shoot out in a very irregular and unco-ordinated fashion. This leads to the conclusion that the child's brain needs organization, and it is the study of the experiments performed to determine the development of voluntary movement that we will now consider.

(2) PSYCHO-PHYSICAL ANALYSIS.

Expriments in Voluntary Movement Bearing on the Pedagogy of Writing.

It is now our purpose to review briefly a few studies made upon children and adults by psycho-physical methods to determine the rapidity, accuracy, strength and maturity, and fluctuating periods in the development of voluntary movements, especially those of the hand; together with a treatment of the experiments bearing on the specialized form of voluntary movement, namely writing, taking up such studies as bear on practice and habit, movements in writing, cross education, the relation of accuracy in handwriting to school intelligence and sex.

RAPIDITY OF MOVEMENT.

Dr. W. L. Bryan (6, Development of Voluntary Motor Ability), in Worcester, and Dr. Gilbert (19, v. 1), at Yale

and Iowa (19, v. 1), have experimented upon the degree of rapidity with which children of different ages were able to tap an electric key which automatically recorded results. Dr. Bryan tested 789 children, ranging in age from five to sixteen. By means of the electric key, he tested four sets of arm muscles, shoulder, elbow, wrist, and metacarpo-phalangeal finger-joints. In order to secure the separation of these sets of muscles, the arm of the subject was clamped to allow movement only of the specific set of muscles. The test was to discover the greatest possible number of taps the subject could execute in five seconds.

The following tables for boys and girls give the arithmetical means of the test (right arm) of all the boys and girls of a given age.

TABLE A.—BOYS.

Age.....	5	6	7	8	9	10	11	12	13	14	15	16
No.....	14	26	35	33	43	37	36	33	34	41	32	26
Finger.....	19.6	19.5	21.0	23.1	24.4	25.2	27.0	29.3	28.7	31.5	31.6	33.9
Wrist.....	20.1	23.0	23.7	26.3	27.8	28.5	30.3	31.6	32.3	33.0	34.2	35.9
Elbow.....	22.7	23.5	24.2	26.1	28.2	28.1	29.3	29.9	31.0	32.7	31.5	32.7
Shoulder.....	18.4	19.8	20.5	22.3	24.1	22.6	24.1	25.0	25.5	27.2	26.3	28.7

TABLE B.—GIRLS.

Age.....	6	7	8	9	10	11	12	13	14	15	16
No.....	28	32	33	43	37	36	33	34	41	32	26
Finger.....	19.8	20.7	22.2	24.0	25.8	27.1	28.2	30.3	29.5	29.1	31.3
Wrist.....	21.6	23.1	24.3	25.5	28.5	30.4	31.6	33.2	30.5	30.9	33.3
Elbow.....	22.7	23.2	24.4	25.4	27.5	28.6	29.4	30.5	28.8	29.3	30.1
Shoulder.....	19.9	20.2	21.9	22.7	22.6	24.9	25.7	27.5	26.6	26.0	27.9

Dr. Gilbert has made two studies upon rapidity of tapping, one upon New Haven children and the other upon Iowa children. The elbow, in his tests, was held free from the table and the arm was in no way clamped. The subject tapped with the finger, but the movement must be interpreted largely as that of a wrist movement. The tests were made on approximately fifty children of each sex, and each age from six to seventeen years. The number of taps in five seconds for both sexes is shown in the following table:

TABLE B.

Age...	6	7	8	9	10	11	12	13	14	15	16	17	18	19
N. H. B.	21.0	22.8	24.9	25.8	27.7	29.7	30.3	29.8	31.2	31.3	33.0	35.0		
I. B.....	22.1	23.3	25.8	27.1	28.3	28.1	30.1	31.1	32.4	34.0	34.0	34.4	36.0	36.7
N. H. G.	19.7	21.2	23.9	25.0	26.9	27.8	29.6	28.1	28.0	29.8	31.8	31.5		
I. G.....	22.3	24.2	26.0	26.7	26.2	28.0	29.3	29.5	29.4	31.3	32.2	33.8	34.3	35.3

Conclusions: The rapidity of motor ability of the hand and arm, for tapping exercises, increases, on the whole, with age and does not reach maturity until the adolescent period. This fact is demonstrated by both of the studies from which the tables given were taken. From the sixth year the rate increases through the pubescent period, with some few fluctuations. To show how immature this movement is at the age of entering school, the following table of percentages is given, assuming the rate of tapping at sixteen years as 100 per cent.

TABLE C.

	Per cent. of 16-year ability possessed at 6 years of age.		Per cent. of 16-year ability acquired between 6 and 16 years.	
(Bryan.)	Boys.	Girls.	Boys.	Girls.
Finger.....	57	63	43	37
Wrist.....	64	65	36	35
Elbow.....	72	75	28	25
Shoulder.....	69	71	31	29
(Gilbert.)				
Hand (N. H.).....	64	62	36	38
Hand (Iowa).....	65	69	35	31

Because the subjects in Dr. Gilbert's tests held the arm entirely free, while the arm was clamped in those of Dr. Bryan's, it seems hardly fair to directly compare the two tests, as the movements in the first-mentioned test consisted probably of all four of the movements studied by Dr. Bryan.

The tables representing the results of the tests show that girls mature earlier than boys in rapidity of arm and hand movements. With the exception of one test, the girls in Table C have at the age of six reached a larger percentage of their 16-year ability than the boys. It also shows that girls at the age of thirteen have practically

reached maturity, and that after that age the rate in some cases actually decreases. Boys seem to increase their ability very materially until after the age of fifteen. Bryan's test gives the following results for girls of thirteen years of age: 97 per cent. in the finger test, 99 per cent. in the wrist test, 101 per cent. in the elbow test, and 98.2 per cent. in the shoulder test.

Another result of the tests was that the rapidity of movement in tapping in the hand and arm tends to be the greatest when the rate of growth in height and weight is least. The process of anabolism in adding new tissues seems to interfere with the dexterity of movement. In the data of Bryan, as shown in the table given below, the tenth and fifteenth years are the highest in growth rate, but lowest in tapping ability. As shown by the table, the years of retarded tapping ability in the New Haven study are the ninth, fifteenth and seventeenth, while the years of accelerated growth rate are the ninth, eleventh, thirteenth and fifteenth.

The rate of improvement fluctuates or proceeds by marked rhythmical vibrations, sometimes very rapid, again slow, and in some years a decrease is shown from the rate of the previous year. The tables of both Bryan and Gilbert show four periods of acceleration and four of retardation in rate between the years 6 and 18, though for some years there is a slight divergence from this general statement. The years of highest rates for boys are as follows:

Worcester	8th and 9th	11th	14th	16th
New Haven	8th	10th and 11th	14th	16th
Iowa	8th	12th	14th and 15th	18th

The years of lowest rate are as follows:

Worcester	10th	13th	15th
New Haven	9th	13th	15th
Iowa	11th	13th	16th

Another conclusion of importance is that the more central or fundamental movements tend to earlier maturity than the less central or less fundamental movements. In table D is shown the relative immaturity of the finger movement. Dr. Bryan's tests offer evidence upon this point, yet no one of the movements in a strict sense, except that of the finger, can be considered exclusivly accessory or fundamental. As will be noticed the finger has acquired in both boys and girls of six a smaller percentage of its ability at 6 years of age than any of the other parts; the wrist also shows less development than the elbow and shoulder. In the following table the rhythms in the growth in power are shown. Each retardation with its succeeding acceleration is thought of as a period, i. e., in the case of the boys there are four periods: 6 to 9, 9 to 12, 12 to 14, 14 to 16; in the case of the girls, three periods: 6 to 10, 10 to 13, 13 to 16. In this the tapping ability at 16 years is taken as 100 per cent., and the figures in the columns indicate the percentage of this 16-year ability added in each of these respective rhythms.

TABLE D.

GIRLS' RIGHT ARM.

Age:	Up to 6 years.	6-10.	10-13.	13-16.	Total at 16.
Fingers	63	20	14	3	100
Wrist	65	21	14	0	100
Elbow	75	15	10	0	100
Shoulder	71	10	18	1	100

BOYS' RIGHT ARM.

Age:	Up to 6 years.	6-9.	9-12.	12-14.	14-16.	Total at 16.
Fingers	66	14	14	7	7	100
Wrist	64	13	11	4	8	100
Elbow	72	14	5	9	0	100
Shoulder	69	15	7	4	5	100

These tables show (1) that the elbow and shoulder movements in both boys and girls have reached a larger per cent. of their mature power than the finger and wrist movements, the finger being without doubt more of an

accessory movement and of later evolutionary development; (2) that after 9 or 10 years of age the finger movement acquires a large per cent. of its ability, 28 per cent. in the boys and 17.5 per cent. in the girls. In another series of tests Dr. Bryan reached the same conclusion, namely, that the shoulder grows more slowly, the elbow slightly faster, and the wrist and fingers very much more rapidly. The rate of tapping for the wrist and fingers does not gain much upon the shoulder until the eleventh year, and then the finger rate, relatively, springs forward with much acceleration. The probable explanation is that the shoulder, as a central movement, has passed the period of extreme nascency very early, the elbow follows, the gain of the wrist is still later, and the period of nascency for the fingers is surely not until after the tenth year, and its real culmination in power is probably not reached until the sixteenth year.

Bryan found that the mean rate of boys slightly exceeds that of girls at all ages except where retardation of growth in boys coincides with acceleration of growth in girls. It might also be mentioned in passing that there is less bilateral asymmetry of development in the rate ability of boys than in that of girls, and that boys develop more rapidly on the right side. The left-handed persons examined showed decidedly less mean difference between the right and left sides, and less bilateral asymmetry than did right-handed persons.

In Gilbert's tests the age of fatigue was found to be about eight. Girls tired more easily at 13 than 12, and boys more quickly throughout; but the boys tapped faster, the average number of times in five seconds being 29.4, while the average for girls was only 26.9.

Gilbert also found out that all children of all grades react in about the same length of time just before those

ages in which changes of growth manifest themselves, viz., 11 and 16. The average reaction time for all ages for bright children was 20.7 hundredths of a second; for those of average ability it was 21.3; for dull children 22.4. Thus it will be seen that bright children react much more quickly than dull children, and we judge of a child's mental ability by the quickness with which it is able to act.

Lombard (28, v. II) experimented on men in lifting weights, mostly by means of the flexor muscles of the second finger, and an attached pen recorded the results. The hand and arm were securely fixed on a convenient rest. After 110 seconds of continuous work the subject could hardly lift the weight, but shortly began to recover, and during the next half of a minute each of the succeeding contractions was higher than the one which had preceded it. Fatigue then again began to manifest itself and the contractions became smaller. During 12 minutes the ability to voluntarily contract the muscles with sufficient strength to raise the weight decreased and recovered five times, due probably to functional changes in the central nervous system. These periods were often almost rhythmical, but displayed many variations. On the relation of fatigue to the rate of rapidity of voluntary movement Bryan has this statement: "The maximum rate of rhythmically repeated voluntary movement in a given individual is sufficient in amount and in constancy to indicate local and general subjective conditions, as excitement, general and local fatigue, local cold, and the improvement with age. The change of rate with extreme fatigue is large in comparison with the mean rate of improvement with age" (6, p. 174).

ACCURACY OF VOLUNTARY MOVEMENT.

We have as yet no great amount of detailed study into the normal relations of voluntary movement to conscious-

ness. The topic has nearly always been treated from the standpoint of perception of movement. It must be kept in mind that movement enters consciousness not only as perceived, but as intended. Conscious life is built up on the basis of the reflex arc; hence the efferent portion as well as the afferent should be studied. Movement begins as early in life and as far down in life as any sensation; the development of voluntary acts is from the lower to the higher.

Woodworth's experiments (44, v. 3), carried on in the laboratory of Columbia University during the years 1898-99 take up the relation of incoming and outgoing currents in normal individuals, and also the relative accuracy of the movement under the control of different senses. It is very important to investigate the accuracy of movement since it is accuracy that makes all movement useful and purposeful. "Movement must have a particular direction, a definite extent or goal, a definite force, a definite duration, a definite relation to other movements, contemporaneous, preceding and following" (44, p. 4).

Tests.—A kymograph carrying a continuous roll of paper 24 centimeters wide, at a rate of 1-5 mm. per second, was rotated on a horizontal axis. On the drum lines were ruled, each to be the exact length of the one preceding. The experiment was varied in several ways. Sometimes the normal was a seen line to be copied, time after time, by the subject; while at other times the line was reproduced from memory. Sometimes a line was previously drawn on the moving paper, at right angles to the direction of the movement, and the movements were required to terminate just on that line. The subject was impressed with the idea that he must make the present line equal to that immediately preceding, the width of the slit on the drum being so adjusted that the subject saw the line he had just made.

Conclusion.—The relation of the accuracy of a movement to its speed is shown in Fig. 2 below (44, p. 29).

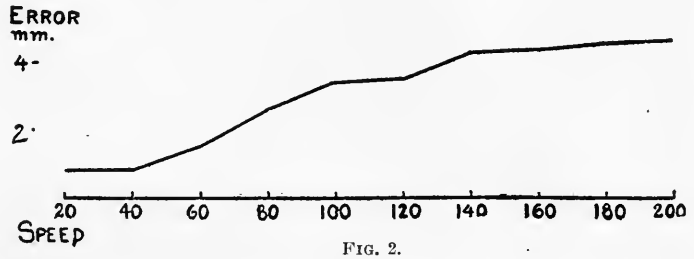


FIG. 2.

In a general way the movement loses accuracy as the speed is increased, but it is not true that equal increments of speed produce equal increments of error, for the line of ascent in the diagram is steeper in the middle portion than at either end. It will be noticed that no perceptible increase in error accompanies the increase of speed at either end. For instance, movements at 40 per minute, intervals of 1.5 seconds, are on the whole quite as accurate as movements at 20, and movements at 140, 160, 180 and 200 are all about equally accurate. By way of a general explanation it may be said that an interval of 1.5 seconds allows time for all the finer adjustments at the end of a movement that can be done in an interval of 3 seconds. Therefore there is a lower limit beyond which decrease in speed does not conduce to greater accuracy. In the same way, at the upper end there is a limit beyond which increase in speed does not produce much further inaccuracy. The explanation of this seems to be that beyond a speed of 140 to 160 movements per minute it is no longer possible to control the movements separately, hence much has to be left to the automatic uniformity of the hand's movements, and this does not seem to diminish as the speed increases.

The results of the muscle sense test is shown in Fig. 3.

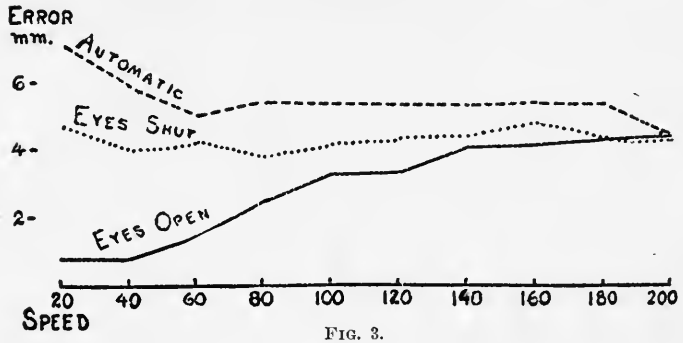


FIG. 3.

This shows the relation when the eyes are closed, and also when the movement is careless or automatic. The automatic movement gains slightly in uniformity as the speed increases, while the studied movements made with eyes closed are almost equally accurate (or inaccurate) throughout. The correlation between accuracy and speed is much slighter than when the eyes are used.

Concerning the results obtained from the three movments it may be said that the one governed by the eye was much more accurate at low speed, the one made with the eyes shut, though less accurate than the first, is still decidedly better than the careless movement. This was found to be true at low speed, and is less and less the case as the speed is increased. We might say in other words that at a high rate of speed the accuracy contributed by voluntary attention, using either the muscle (joint) sense or the eyes, amounts to zero, and that when the speed is decreased, the accuracy due to visual control is greatly increased, but not that due to the muscle sense.

INITIAL ADJUSTMENT AND CURRENT CONTROL.—The initial adjustment for any movement is complex; it includes the innervataion of different muscles one after

another. It is undoubtedly true that the co-ordination adapted to produce a straight line is probably more complex than that to produce certain curves. The first impulse includes also a command to stop after a certain distance; these later effects of the initial impulse are probably reflex in some degree at least. The proper continuation of a movement which has been started seems to be dependent on the preservation of the sensibilities of the arm making the movement, and yet the first impulse contains in some way the entire movement. A graphic demonstration of the later adjustment is not easy, but Woodworth (44, p. 55), by means of a rapidly rotating kymograph obtained a curve of the speed of the movement—similar to the curve of muscular contraction—and any little additions to the movement could be detected.

Conclusions.—The accuracy of the original impulse is slight compared with that added by the later adjustment, when the speed is low and the eyes are used; otherwise almost as great. In other words, in the situations which permit great accuracy, that accuracy is due mostly, not to the initial adjustment of the movement as a whole, but to the current control, consisting of finer adjustments. Woodworth thinks that in addition to the inaccuracy of perception and inaccuracy due to the failure of the movement to obey our intention, there is also an inaccuracy in the intention itself, or in the process of adjusting the movement to the perception (44, p. 71).

SENSORY BASIS FOR CONTROL OF MOVEMENT.—Woodworth (44, p. 71), endeavored to find what sensations are relied on for the government of the extent of a movement. Among other tests he tried one in which the subject wrote with eyes closed, and from this the following conclusions were drawn: (1) at the ordinary rate of speed the writing of a single letter or a short word can be done

as well with the eyes closed as with them open; (2) extreme slowness is a disadvantage when the eyes are not used; (3) if several words are written with the eyes closed, the alignment is lost or some other constant error makes itself evident. The conclusion he reached from observing people write with the eyes open is that when the speed is low enough to permit of fine secondary adjustments, the eyes assist greatly in forming the letters just right.

If we introspect our act of writing we shall find that we never look at the movements of our fingers, but seemingly at the letters just written, and yet if we watch some one else write, we will find that the eyes move but little and do not follow the form of each letter, but seem to keep track in general of where he is, to preserve the alignment and spacing, to keep an equality in the letters, and to avoid losing his way when in the midst of a word and so misspell it. Hence we conclude, says Woodworth, that in forming the letters we come to depend mostly on the muscular and tactile sensibility.

Downey, in experimenting in the Psychological Laboratory of Chicago University to determine the control processes in modified handwriting attempted to throw into relief these control processes by eliminating or distracting some particular control, as, for example, having the subject write blindfolded to eliminate as much of the visual control as possible. Among other results she found (1) no evidence of a voluntary act of writing without a sensory cue of some sort, (2) throughout the whole series of experiments the report coming from the writing in terms either of kinaesthetic or visual sensations and images proved to have a highly important function as a part of the writing cue (13, p. 142).

In considering the results of these two experiments carried on by Woodworth and Downey one must remember

that the subjects were adults, and the conclusions are based on the results obtained from people with well established habits of writing. In the case of adults in whom the writing habit is fully developed, the utility of the visual image may be considered as trifling, but when the function of the visual factor in writing is considered genetically, or where new co-ordinations are attempted by the young child, its value and use is obvious enough. It is said that adult introspection rarely reveals an anticipatory visual verbal image, and there is a tendency among psychological investigators to minimize the value of the visual perception of the result of the writing movement to the fact brought out by Woodworth, namely, that it is directive in the matter of spacing and alignment, etc. Yet as Bawden states: "It is practically impossible to determine with experimental accuracy the degree to which the kinæsthetic is helped out by the visual imagery in writing" (2, p. 390). It is true that the hand-kinæsthetic process is a necessary accompaniment of writing as an act, but not necessarily of the writing-consciousness; for there is a difference between the writing movement which might be a purely physiological event and the consciousness of that movement. This difference may be either in the form of an image of anticipation or of a sensational report of the movement as achieved, either of which might fail to assume kinæsthetic terms. A sensory kinæsthetic report on the movement as it proceeds is usually present, although it varies in different individuals and has a different value for the same individual under different conditions. As a matter of fact, as a conscious control process this kinæsthetic report has great utility, probably functioning in the usual course of writing as a corrective but also at times as an initiative process as well.

Woodworth thinks that the muscle sense is disregarded in judging the extent of a movement when the eyes are used (44, p. 76). The eye tells us nothing about the co-ordination of the muscles, and for the control of the movement in that respect we no doubt have to depend on the sensations from the moving member, as is recognized when we try to write with a numb hand. In this case the eye cannot supply the lack of skin sensations, because we have never looked at the movements of our fingers, but always at the results; consequently no association between the visual sensation of the moving fingers and the proper impulse to set the muscles into co-ordination has been made. In short it may be said that the general and co-ordinating control is vested in the muscle sensation, and the closer control necessary in making one line equal to another is left entirely to the eye when that is used.

INACCURACIES DUE TO PERCEPTION AND MOVEMENT.—Fullerton and Cattell (17) found in their experiments to test Weber's law, in which the subjects drew lines just perceptibly longer and shorter than a given line, that (1) part of the total error in producing a movement may be attributed to inaccuracy of perception, and (2) the remainder to the failure of the movement to obey our intention. To prove this the experimenters required the subject in each case after making a movement to judge, or at least guess, whether the line was too long or too short. As a result the right guesses were too large to be attributed to mere chance, but went to prove that the error of perception is considerably larger than the error of movement.

Münsterberg found in his studies of movement that the accuracy of the reproduction of arm movements was affected by emotional conditions. Bodily vivacity produced a positive constant error; langour a negative constant

error; seriousness a negative constant error, and gaiety a positive (35, pp. 81-88). Münsterberg thinks that it is quite likely that many of the unaccountable variations in accuracy are the result of fleeting emotions.

PRACTICE AND HABIT.

The importance of a treatment of practice and habit in considering the teaching of writing will be readily recognized by all since writing in its last analysis should be considered as nearly an automatic process as it is possible to make it such. The means through which this automatization is brought about is practice.

W. Smythe Johnson (25, p. 64) has carried on some valuable researches in practice and habit, one of his experiments being the drawing of circles from copies. With the exception of one girl of twelve, the subjects were adults. The subjects were impressed with the fact that they must keep the true circle constantly in memory after they took their eyes off the copies to direct their hands. The circles were drawn free hand, no portion of the hand or arm being allowed to rest on the table during the process.

Conclusions—

(1) When practice is carried on until the movements become irregular, the practice becomes injurious, for the irregular movements seem to become incorporated into the chain of reaction as certainly as do those which are purposefully directed. Therefore practice may tend to establish irregular adjustments as well as regular ones; the capital on hand at the beginning of each succeeding practice period is the sum of the preceding practices. If wrong adjustments of the muscles are made, and these gain a place in the chain of subconscious memories, then these adjustments delay the development of the control over the muscles for accurate adjustment. In the experiment bet-

ter results might have been obtained in those cases where the error increased after the third circle, if the practice period had been shorter in the first part of the series and more prolonged later.

(2) Special effort was accompanied by unnecessary movements of the body, but as the action became more habitual most of these distortions disappeared. It is probably true that when there is a tension of some muscles while others are being vigorously exercised, they become influenced in proportion to this tension.

(3) Since some subjects increased while others decreased the size of the successive circles drawn, the conclusion may be drawn that each individual has a certain adjustment of the muscles in writing and drawing which should be taken into consideration when training the muscles for accurate adjustment.

In the experiment made by Johnson, continued from six to eleven days, in which each of seven persons tapped at the corners of an equilateral triangle, it was found that the greatest gain in rapidity of triangular movements of the hand, as well as in the regularity of successive movements, were made in the early part of the practice, before fatigue set in. Where the exercise was continued, after a short interval there was a renewal of the effort. This goes to show that short periods of practice often repeated make for more rapid development of the accurate adjustment of voluntary movements than few periods of longer duration. It takes time for muscular adjustment to take place. In the words of Dr. James, "We learn to skate in summer."

In the experiment performed by Swift (40, p. 170), in which two balls were kept in the air with one hand, it was found that progress was never uniform, but always by jumps. For several days the learner would show no gain, or perhaps even fall back, and then he would go rapidly

forward. During these plateau periods, in which the subject did not seem to advance, he was, it is believed by psychologists, gaining in confidence; in other words, the co-ordination of muscles was being developed and made habitual for future use.

In Bryan and Harter's studies in telegraphy (7, p. 345), the plateaus in the practice curve mark, they say, the time when the successful co-ordinations are made automatic. Automatization is going on during the entire learning process, but more than at any other time during the plateau period.

As a conclusion concerning the learning of typewriting, Prof. Book (4, p. 26) says: "To try to crowd ahead before the elementary habits are sufficiently mastered to make safe the taking of a forward step, or to fail to perfect the elemental associations which must be combined to form the higher and more direct method of writing, is fatal to progress or interest." From his experiments he concluded that at certain definite stages of advancement, where a special habit, or group of these special habits is being perfected, the learners are especially liable to settle down to a rate of work far below their highest possibilities, and this low rate of efficiency tends to become habitual. Bryan and Harter concluded also that only intense effort counts in practice. As a result of the memory test, Book concludes that special emphasis should be given to the importance of time intervals in learning, and that the whole problem of determining the most economic periods of work and rest for all kinds of learning should be opened up for careful consideration.

In the Yale Psychological Labratory Miss Smith, under the direction of Dr. Scripture (38, Education of Muscular Control and Power), made some experiments in which the measure of accuracy was the ability to insert a needle into

a hole .1285 inch in diameter. Twenty experiments were made, first with the left hand, with a result of 50 per cent. of successful trials, and immediately 20 experiments were made with the right hand; result, 60 per cent. of successful trials. On the following day and on each successive day 200 experiments were taken with the right hand. The percentage of successful trials ran as follows: 61, 64, 65, 75, 74, 75, 82, 79, 78, 88. On the tenth day 20 experiments were performed with the left hand, and the result was 76 per cent. of successful trials, 26 per cent. increase without practice. This increase of steadiness in the unpracticed hand was thought to have been due to a training of the attention, since by a special effort of attention, after a week's practice it was possible to insert the needle into the hole successfully for any given ten times. Also because any distraction of attention, as noise, invariably lowered the per cent. of steadiness, as was also true in case of bodily or mental fatigue.

As to the effect of different directions of the attention it may be added that concentration upon the muscular movement to be performed was unfavorable, but fixation of attention upon the objective point to be reached by the needle was productive of the best results. Fatigue of the muscles of the eye was a more noticeable result than fatigue of the muscles directly practiced.

Conclusions—

(1) Steadiness of movement can be increased by practice.

(2) This increase of steadiness does not seem to be limited to the control of the muscles immediately trained, but affects the control of the corresponding muscles on the opposite side of the body.

(3) This training seems to be of a psychical rather than of a physical order, and to lie principally in the steadiness of the attention.

Woodworth, in his studies of the accuracy of voluntary movements, before taken up, concluded with Johnson and others that only successful practice counted, and that unsuccessful practice was a positive detriment, inasmuch as wrong adjustments were made delaying the development of accurate adjustments, and that practice of the unsuccessful kind discouraged the subject and caused him to put forth less effort in future practice.

CROSS-EDUCATION.

The term "cross-education" is used to express the fact that the effect of practice on one side of the body is transferred in some degree to the unpracticed side. The results from Scripture's experiment in muscular control and power, treated in the preceding pages, bear out the fact that the effects of practice are transferred, as does also Bryan's tapping test gone over in a preceding portion of this writing.

Davis (11, p. 6) has investigated quite extensively along the line of cross-education, and his results will be taken up very briefly. The experiments were carried on during 1898-99, and were for the purpose of establishing more definitely the fact of cross-education and if possible to find out the cause. Tapping and lunging at points, as well as lifting weights, were some of the tests.

CONCLUSIONS.

(1) The effects of exercise may be transferred to a greater or less degree from the parts practiced to other parts of the body; the transference being greatest to symmetrical and closely related parts.

(2) There is a close connection between different parts of the muscular system through nervous means; this connection being closer between parts related in function or in position.

(3) Will power and attention are educated by physical

training; when developed for any special act they are developed for all other acts.

As an explanation of the cause of cross-education, Davis says in substance that there is no doubt but that the most important effects of muscular practice are central rather than peripheral. There are two central effects to be distinguished, (1)that dependent on the development of motor centers; that is, through exercise; (2) that dependent on the development of psychical factors, notably attention and will power. Of these two effects he considers the first as being more important, since in the tapping test close attention and a strong will power were hindrances, but in tests requiring strong effort these factors are useful.

MOVEMENTS USED IN WRITING.

Investigations have shown that the nervous mechanism involved in the attempt to be precise with the fingers probably requires an adjustment of a larger area of muscular and nervous tissues than those of any other movement of the body. It is said that precision in drawing a fine line requires steadiness not only of the finger movement itself, but of the hand, the whole arm and even of the whole body. Precision seems to involve two processes, (1) steadiness of the central organism as a platform upon which to rest, and (2) the finer nerve adjustments of the most complex nervous elements (8, p. 58).

Hancock (22, Motor Ability) has investigated this phase of the problem in his experiment testing the ability of children to stand still. The test was to have a child with feet close together, hands at side, and attention on some distant object, stand still for one minute. An ataxagraph, which automatically registered the swayings of the subject upon smoked paper, was attached to a cap worn on the head. In this way 168 boys and girls of Worcester, aged 5-7 years, were tested.

Results: The tests showed that during these two years the girls gained in steadiness 32 or 33 per cent. of the power of control at five years of age, while the boys gained about 15 or 16 per cent.

H. S. Curtis, in his study of inhibition, tested the ability of children of various ages to sit perfectly still, and as a result he found that an ordinary child cannot on an average sit still more than 30 seconds when under five years of age, and children from five to ten years of age are unable to sit still for more than one and one-half minutes at any time. He explains this on the grounds that the higher centers of voluntary control are not developed in any degree until a late period of child life. It was found that mental occupation aided greatly in the control of muscular restlessness.

PERIPHERAL UNSTEADINESS.

Corresponding to the larger swaying of the central movements, there are numerous small vibrations in the peripheral muscles involved in the adjustment for fine movements. Though these movements are imperceptible to ordinary observation, experimentally they are always demonstrable. In early infancy they appear in the form of apparently nervous twitchings that constantly occur in nearly every muscle of the body, even during sleep. These are perfectly normal and are signs of health. They tend to disappear in conditions of lowered nutriment, and in idiotic infants fewer are found. As the infant grows these movements become less noticeable, gradually tending to disappear as the nervous and muscular mechanism is perfected; the lower mechanisms pass under control of higher brain levels.

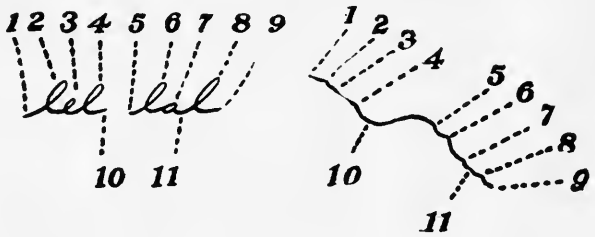
ACT OF WRITING.

The writing movements are made up of different factors, and yet all these must fit each other perfectly. The finer

pen strokes made with the fingers must not interfere with the movements of the arm across the page. The muscles of the arm must not contract until the finger-work is done, and then the arm must carry the hand forward to a new point where the fingers execute new pen strokes. In forming letters the child seems to use finger movements almost exclusively, the hand and arm moving only in the intervals between the finger movements. The child forcibly moves the hand and arm because the fingers become so cramped that they must be relieved in a measure by a moving of the hand forward. At this stage of learning to write there is a lack of unity between the finger movements and those of the hand and arm.

Dr. Judd found that there were certain parts of the hand which did not participate in the finger movement, i. e., the fifth metacarpal bone just behind the little finger. He found that by attaching a tracer to this bone he could discover what movements belonged to the hand by means of the additional writing or tracing. The instrument did not record (1) slight movements upward or downward, and (2) movements of supination or pronation—the rotating of the hand so that it tends to lie flat on its palm (26, p. 170).

One of the records is shown in Fig.15 (26, p. 172). On the left appear the letters written, and on the right the tracer-record. The most obvious result is that the hand participated only in the forward movement and the fingers'



work seemed to be to form the letters. The lines between 1 and 3 in the tracer-record represent the whole movement of the hand during the writing of the letter l and the first stroke of the letter e. In the tracer-record the total movement of the hand from the top of l to the top of the next l furnishes a striking illustration of the relation between hand movement and finger movement in forming the letter a. The movement 6-7 in the tracer-record shows the part played by the hand in making the downward stroke of the l and in carrying the fingers forward to the position from which they did the greater part of the work of forming a. Contrast 6-7 with 2-3, which represents a similar movement, and a characteristic fact in all hand movements will be observed, namely, that in almost every case the hand does its part in forming a letter before the fingers begin their finer formative work.

Another result observed in this tracer-record appears in the difference in slope of the three parts, 1-10, 10-5, and 5-9. 1-10 indicates the movement of the hand during the writing of the first group of letters. From the slope the indication seems to be that the hand executed a considerable movement from left to right on its own center in the wrist. The slope in the line 10-5, brought about by the movement executed during the pause between the writing of the two groups of letters, indicates that this movement was made from an entirely different center; an arm movement centered at the elbow instead of at the wrist, as was the case in the movement 1-10. A wrist movement from right to left is indicated by the convex form of the line just before 5. The interval between the groups of letters seems to have been employed in executing an arm movement which carried the hand forward and in executing a backward wrist movement which prepared the hand to go on with the new series of forward movements recorded from 5-9.

General Conclusions:—

(1) In ordinary writing the fine formative movements are executed by the fingers.

(2) The movement which carries the fingers forward are executed by the hand or arm.

(3) The pauses between groups of letters are utilized for longer forward arm movements which bring the hand back into an easy working position.

(4) A comparison of the different types of co-ordination obtained from the experiment shows that each individual has his own peculiar combination of arm and hand and finger movements, and that forms of co-ordination are as numerous and various as are the individuals who write.

(5) The hand usually requires a few strokes at first to adjust itself; the necessary adjustment sometimes being brought about by a greater emphasis on finger movement, and sometimes by a more pronounced hand movement.

(6) Any change in the condition under which the subject writes will modify the character of co-ordination, i. e., changing from a hard to a soft pencil, from a vertical position of the paper to an oblique, will produce variations in the character of the muscular co-ordination, even when the product of the movement (the written letter) does not seem to be changed.

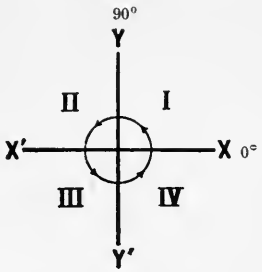
PRONATION.

There is another movement which enters into the total complex of writing movements and is well worthy of notice before passing to another subject. This movement is known as pronation. It consists in rotating the hand so that it tends at all times to lie flat on its palm. This rotary movement is possible because the bones of the forearm, the ulna and radius, fasten at the wrist in such a manner that they can turn the hand, causing the palm

to lie either up or down. When the palm is downward, or prone, the position is due to the movement of pronation. In the course of writing a line across the page most adults make a slight movement of pronation. The gradual modification in the position of the arm axis with reference to the edge of the paper, which takes place during the writing of a line, requires some definite form of compensating movement, if the slope of the letters is to be kept uniform with reference to the edges of the paper (26, p. 181). Specimens of ordinary handwriting show that only partial corrections of the slope of finger movements have usually been effected by ordinary writers, i. e., the slopes of letters at the end of a line, or at the end of a word, are usually greater than the slopes at the beginning. Failure to correct the slope gives to the line and to the word a somewhat irregular appearance commonly noticeable in ordinary writing, and nearly always found to a considerable degree in the writings of children. The movement of pronation effects all the corrections in slope that are possible, since it tends to throw the upper end of the pen toward the writer and thus to give the pen a movement more nearly parallel to its first movements at the beginning of the line. This movement of pronation is one which most adults have, but in only a partially developed degree. Pronation as a corrective movement is a factor necessary to secure uniformity whatever the slope.

SLOPE.

Most of the movements used in writing were found by investigations carried on by McAllister (32, Movements Made in Writing) in the Yale Psychological Laboratory to be movements following the direction of the radii in quadrants I and III in the figure below. It was found that if



quadrant I be taken as the standard, that quadrant II required for the average of all movements 30 per cent. more time; quadrant III 10 per cent. less time, and quadrant IV 25 per cent. more time. Thus showing that the slowest movements are in quadrant II. This result indicates the direction in which we might expect the hand to move if one were asked to make some long strokes with a pen, or some vertical lines, rapidly. These would tend to slope towards the right rather than towards the left.

In McAllister's experiment with kindergarten children in the New Haven public schools the pupils drew rings. He found that the slant in some papers varied from 0 to 175, but in most cases there was much less variety of slant. Each subject made the movement with one continuous swing of the pencil, and no time was allowed to correct the movement, the muscular sense alone governed the extent of the movement in either direction. Since the feeling of effort made by the eye in running along vertical lines is greater than that made by running over horizontal distances of the same length, the results showed an overestimation of the vertical distances, and leads to the conclusion that greater effort required to make movements in the direction of the radii of quadrants II and IV causes the distances passed over in those directions to be overestimated by the muscle sense. In many cases the eye

later discovered the error due to the muscle sense, and a desire to correct in later drawings caused the variety of slants found in some papers.

Conclusions:—

(1) Natural slant is the most rapid.

(2) The hand acquires a slope that is usually farther removed from the perpendicular than the model used as a copy, a child usually deviating 10° from the vertical.

(3) The greater the slant to the right from the yy′ axis, the more rapid will be the writing. A slant of about 75° permits legible writing, but as the angle decreases below 70° the legibility decreases rapidly.

(4) A base line is desirable to guide the eye in writing across a page or in lining the letters in a word. Other lines cause the child to give more attention to spacing and height than to form and movement.

(5) Free, full forearm movements in a horizontal plane are made more rapidly towards the body than away from it, up strokes taking more time than down strokes.

(6) It is desirable to have the child connect the letters in a word, even though in later life these connections are in many cases left out. The reason for this is that as the child slowly moves the hand in producing the up stroke, the eye has time to estimate distances, and the tops of letters are for that reason kept very nearly in line. Without these guiding lines, the letters are raised from the

t

a

base line, i. e., c .

(7) In the very first stages speed should be of little importance to a child learning to write. The fundamental thing is to educate the muscles so that the proper coordinations may be made to form legible characters.

(8) It is a great strain on the hand and arm to attempt to keep a constant pressure on the paper for all strokes. Raising the pen or pencil from the paper removes this strain. After the child has acquired some facility in the art of writing, the upward movements may be made much more rapidly and easily if it is not necessary to have the path of these movements on paper. The up stroke at the beginning and end of a word are of no assistance to the reader, hence they may be dropped. Binet and Courtier also found that separated letters may be made more rapidly than connected ones. Adult writing shows the continual lifting of the pen. Shading of down strokes provides a means of relieving the strain by varying the pressure.

(9) For rapid writing only lines essential to the forms of the letters should be on paper.

(10) Each child should be allowed to choose his own size of letters.

(11) Backhand writing is slow and difficult.

BEST MOVEMENT.

Woodworth (44, p. 106) made some experiments in which adult subjects made a series of movements back and forth, i. e., a line of small u's joined together, a line of small m's, etc.

Results:—

(1) The whole arm movement, if hastened, is by all means the hardest physically since it requires the expenditure of the most energy and shakes the whole body.

(2) In uniformity of slant, accuracy and speed, the forearm movement is easily the best of all the movements used in writing.

TYPES.

From an observation of handwriting one finds that most people have an individual style, yet many products of

adult writing show plainly the effects of early instruction (copy) instead of individuality. Preyer distinguishes between natural and artificial handwriting. Children seem to depend on copy to a greater extent than is the case with adults, but as a child advances in years and practice, his writing tends more and more to change over gradually into the natural.

Meumann (31, p. 301) in his experiments and observations found three types:

(1) Masculine,
(2) Feminine,
(3) Children's.

(1) The characteristics of the masculine type is that the pressure is heavier than that of the feminine, and the pressure is distributed so that in every word is shown a place of maximum pressure. To this maximum the remaining innervation is subordinated in a rythmical way, rising or descending in a fixed curve to or from the maximum. This maximum is found sometimes at the beginning and sometimes at the end of words, increasing with the velocity of writing.

(2) Women write faster than men, and as the speed increases the pressure lessens. In the case of men there was more totality of impulse in writing a word or several words, while in the writing of women several maxima are found in a word. Women stop often while writing; men write with more completeness of total impulse, thus allowing more freedom for thought, yet tending to write with greater carelessness than women.

(3) There is found no maximum pressure in the writing of children six or seven years of age; but the separate letters, and in the beginning separate strokes, are written with equal pressure. No rhythmical curve is shown, but an irregular long drawn out one reaching the same height

with every stroke. While increased speed causes fixed rhythmical pressure on parts of words and single letters, the child uses always a longer time, and every stroke is made with approximately equal speed; absolute pressure therefore is less important.

The general conclusion is that adults write with a will impulse for entire words or parts of words, while children use as many will impulses as letters or strokes.

RELATION OF ACCURACY IN WRITING TO SCHOOL INTELLIGENCE AND SEX.

Gesell's experiments (18, p. 395) along this line are the latest and most reliable source of light on the subject. He examined the work of grades I-IX of the public schools of Worcester, Mass., 12,600 specimens in all being classified and tabulated. Each of 105 teachers submitted four sets of representative specimens written by the pupils of her grade:

Group I. Specimens from three best writers in grade.

Group II. Specimens from three worst writers in grade.

Group III. Specimens from the three pupils of highest mental ability as represented by school standings.

Group IV. Specimens from three pupils of the lowest mental ability as represented by school standings.

To each specimen was attached a slip giving desired data about the pupil, as indicated below:

1. School intelligence (as shown by standings): Very Good, Good, Poor, Very Poor.

2. General intelligence (irrespective of standing): Bright, Average, Dull.

3. Motor ability (a careful judgment of the pupil's muscular dexterity, as shown in drawing, sewing, manual training, and general aptness in using figures, hands, and arms): Clever, Average, Clumsy.

4. Facility in writing: Ease, Moderate Ease, Effort.

The following table shows in a graphic way the relation of sex, school intelligence, general intelligence, motor ability, and facility in writing by classifying the number in each group under these different heads:

	Sex.		School Intelligence.					General Intelligence.			Motor Ability.			Facility in Writing.		
	Boys.	Girls.	Very good.	Good.	Fair.	Poor.	Very poor.	Bright.	Average.	Dull.	Clever.	Average.	Clumsy.	Ease.	Mod. ease.	Effort.
Group I.....	122	193	86	105	82	30	12	122	168	25	124	174	13	187	115	10
Group II.....	238	77	26	54	92	88	55	60	160	95	18	124	152	52	103	148
Group III.....	147	168	236	64	5			269	46		159	146	17	171	111	26
Group IV.....	174	141			22	123	170	11	97	204	23	149	137	56	141	104

Conclusions:

1. For a large number of cases, accuracy in writing of the pupils of the elementary grades tends to vary directly with school intelligence.

2. From the fifth grade up through the high school, girls as a class write more accurately than boys.

3. Boys as a rule show a greater tendency toward incoordinated writing as early as the first grade and up through the high school.

4. The sex differences in writing become marked about the age of ten, and are largely attributable to the mental factors.

5. If writing is an index, then painstaking or careless qualities in a motor function bespeak, in pupils of elementary grades, the same qualities in general school work.

Kavanagh (27), in his investigations of civil service examination papers in geography, history, arithmetic and English, written by 1100 boys, found the lowest correlation between handwriting and other abilities. He believed that the coefficients for handwriting were somewhat lower than Pearson's (Biometrika, v. V) for the reason that the distribution of the groups differed.

CHAPTER IV.

PEDAGOGY OF WRITING.

It now remains as the work of this chapter to sum up the results of the experiments and observations cited and discussed in the previous one, and to apply these in a practical way to the teaching of writing. The subject of writing has been looked upon in the past as being of minor importance, hence little pedagogical discussion of a psychological character has centered around the topic, and teachers have followed this system of penmanship and the other without realizing that there might be some fundamental truths which ought to underlie the teaching of all writing. The very fact that we have different systems of writing, as we have of physical training, clearly demonstrates that rock bottom, psychologically, has not been struck. When we come to the real, vital facts in writing there must of necessity be a universal system, and it is with a desire to attempt to "blaze the trail," as it were, that these experiments have been examined, parts extracted and discussed, and the following effort to apply the conclusions educationally has been made. If it does no more than to interest and direct educators' attention to the possibilities of the subject, the attempt will not have been made in vain. The topics discussed in the following pages are suggestive and vital; no attempt will be made to cover the whole field or to enter into all the details possible under any one topic discussed.

ORIGIN OF HANDWRITING.

From observing his child, Baldwin (3, p. 86) found that she showed great fondness for drawing and writing as soon as imitation was well fixed, or from the 19th month to the middle of the 27th. Up to the 27th month there seemed to be no connection, apparently, between a mental picture in consciousness and the movements made by the hands and fingers in attempting to draw; that is, the drawing appeared to be the vaguest and most general imitations of the teacher's movements, not the tracing of a mental picture. This is well illustrated in the scribbling of young children in imitation of the fast movements observed in adults' writing. The resulting product does not seem to bother the child in the least and he is perfectly satisfied with going through the quick movements regardless of the correctness of the resulting forms. From angular straight lines the child gradually learns to make curves, and from movements in one direction exculsively, he proceeds to reverse, and instead of attempting simple figures only, more intricate, complex ones are attempted. Baldwin found that in the 27th month his child came into the idea of tracery imitation, or the sense of connection between what was visible in her own consciousness and the movement of her own hand. Then the attention was directed to the form instead of being centered upon the movement, and an effort was made to imitate the visible figure by using different movements; thus the "trial and success" method seems to be the one by which the child comes into his ability to write.

The acquisition of writing involves three series of sensations: (1) The child gets his visual form series first since he can recognize and even name figures, pictures, etc., before he draws or sees them drawn; (2) the child in

drawing or writing moves his hand thus getting sensations from the hand itself according to its locality at any moment, i. e., there will be touch sensations, joint sensations, muscle-tension sensations, etc.; (3) the child also sees other people's movements, as well as his own; this gives him a more or less exact additional series of eye sensations, according to his ability to see in such sets of movements a regular visual form.

Tracery imitation is not writing, as there is no sensation of movement whereby the operations of the hand are held in control. The arm at first appears to be capable of extremely few movements, the elbow one, and the fingers of none; consequently the child starts with few definite arm movements. Later his muscular movements get broken up into units and are recombined into new series.

LEARNING TO WRITE.

It is a well-estabilshed fact that the child gets little or no direct help in the development of writing movements from inheritance. Walking is largely provided for in the brain tracts which the child inherits from his ancestors (26, Typical Form of Motor Development). In learning, he has only to assist the already established organization to mature, while some instances are on record (Kirkpatrick's child, Fundamentals of Child Study) where the individual did not even have to learn. The writing activity is very much more a product of individual development. If one should observe a child just beginning to learn to write, one would be struck by the excess of muscular activity present. The pencil is grasped too tightly, the child moves parts of his body that do not contribute to writing, i. e., the other hand, the head, the face, etc. This excess of movement is due to what is technically known as diffusion. The meaning of the term is that the nervous impulse has

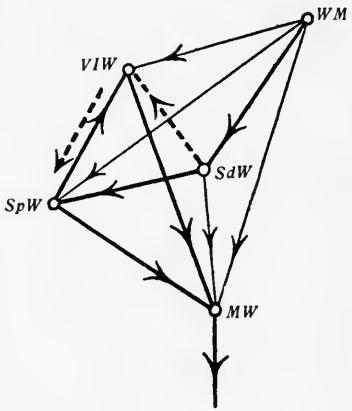
not been carried through the brain along any single well-developed tract, but is scattered or diffused throughout the undeveloped brain tissues in such a way as to pass out at a number of different points, thus giving rise to a great number of unnecessary movements. At a later stage this diffusion does not show itself in excess of movement, but appears in irregularities found in lines made by children, i. e., slipping to one side in a well-intended line means that certain muscles of the fingers or hand did not receive just the right amount of stimulation, but were stimulated, as compared with the other muscles, to excess.

Overproduction of movement, as diffusion, has advantages as through such excess of movement individuality is developed. A child cannot set about performing an act voluntarily until he has discovered it in some way, and then from the excess of movement the right factors are selected. The organism of the individual determines to some degree the movements selected. Teachers should recognize the diffuse character of movement in its earlier stages, i. e., the child's constant movement of the face during writing; a tendency to move towards an object of interest and attention, as bringing the head down to the paper while writing, the bending of the body over the task to be performed, etc. These are all perfectly natural, and it is the work of the teacher to help the child to overcome such tendencies. In order to do so the best external conditions should be furnished and attention given to the cultivation of correct position, etc.

ANALYSIS OF WRITING.

Meumann (31, p. 300) found that children write letters singly, for each stroke a new impulse, just as in reading the child sees and reads only one word at a time at first. Still speaking precedes writing, so the child speaks but a

single syllable while the adult pronounces a word, phrase or whole sentence. He concluded that familiar words were not written as single letters, but the word was recognized as an entirety; however, when the mechanism of writing is concerned, as in dictation, translation or writing from memory, the words have to be cut to pieces. These three cases have this in common, the motor centers for setting free the impulses of writing are the same as those which concern the motor act of writing. Each time the act of writing is stimulated, these three cases must be distinguished or separated through the parts of the same center. Störring's anatomical chart diagrams the centers of word meaning (WM), of the movements of writing (MW), of the visual image of writing (VIW), the speaking of words (SpW), and the sound of words (SdW).



When dictation is written, the association SdW-SpW-MW and SdW-SpW-VIW-MW is affected. There is association also through the path SdW-WM-MW, and quite frequently the path SdW-VIW-MW is used.

The reproduction of the image of the written word by

the writing of dictation depends on two vital causes, the visual word-placing and the image of the spoken word, or the percept of the spoken word—both are of great value.

Spontaneous writing comes as a result of the mental process WM-SdW-SpW-MW and WM-SdW-SpW-VIW-MW. The conclusion is almost reached that by a broader development of writing, the way over VIW always becomes of less value.

It is seen from the diagram that one writes hearing and speaking, the inner voice, the still speaking, precedes the act of writing. Hearing and speaking we write with the image of the writing ahead of the act of writing, thus the phenomena of anticipation seems to go ahead of all writing. Meumann would have us think that the extraordinary significance of fluent writing is the correct knowledge of the audible analysis of speech, for if the inner voice of writing hastens on ahead correctly, the child writes more quickly, always sure that he knows the elements of the words as they sound, and that he has control of this partial anticipatory writing (vorgeschriebene).

TIME FOR BEGINNING.

There are two questions that need to be considered, (1) when is the child physically fit to learn to write? (2) when does he need to learn? Let us turn our attention to the solution of the first question. Flechsig's investigations showed that when a nerve fiber acquires its sheath, or becomes medullated, then it is functionally mature. He also found that fibers connected with the higher centers are not medullated. The direction of growth of medullation is not from the highest cerebral centers toward the periphery, but in the opposite direction. Consequently the development of these higher centers comes through the movements in the periphery. Writing is acquird by means of the higher centers. Accepting Jackson's Three-Level-

Theory of the nervous system, mentioned before, it has been found that the most simple nervous centers and levels are the most organized, while the most complex is the least. The hierarchy of control when studied shows that movements become gradually more complex, more co-ordinated and integrated, or, in other words, the same muscles are controlled by these three different levels. After movements appear in reflex use, they can only become compounded, or rather complexed. Donaldson's citation of the training of an idiot's hand goes to prove that movement produces development of nervous substance. Should writing be taught in order that the higher centers may be developed, or should this development be brought about by means of other larger movements, such as those brought into play in manual training, drawing, play, etc.? This is a question needing the careful consideration of all educators. It is to be hoped that much light will be thrown on this problem before long by more careful experiments in psychology and physiology. All will grant that the movements used in writing should pass from the control of the highest level to that of the lowest by means of practice, yet the acquisition of writing cannot help being in a greater or less degree a conscious process. However, it must be remembered that whatever is to be done unconsciously in after life should be acquired as unconsciously as possible. At first some little attention must be paid to the forms, but as early in the process of learning to write as possible, the emphasis should be upon the thought to be expressed, thus allowing the sensory impulses to control the writing movements and these will through practice become more or less automatic.

In the experiments carried out by Bryan and Gilbert, it was found that the rapidity of the motor ability of the hand and arm increased with age and reached maturity about the period of adolescence. It was found that when

boys entered school their rate of tapping, as compared to the 100 per cent. rate of tapping at 16 years, was for the fingers 57, wrist 64, elbow 72, and shoulder 69; while the girls stood, fingers 63, wrist 65, elbow 75, and shoulder 71. Thus it is obvious that the fingers of a 16-year-old boy are possessed of almost twice the ability of the fingers of a boy of six. It was also noticed that the more fundamental movements tend to earlier maturity than the accessory movements, i. e., the finger had acquired in both boys and girls of six a smaller percentage of its ability at 16 years of age than any of the other parts, and the wrist showed less development than the elbow and shoulder. After nine or ten years of age it was found by Gilbert that the finger movement acquired a large per cent. of its ability, 28 per cent in boys and 17.5 per cent. in girls. Bryan found that the rate of tapping for the wrist and fingers does not gain much upon the shoulder until the child is 11 years of age, and then the finger rate relatively springs forward very quickly. The period of nascency for the fingers cannot be before the tenth year, and only reaches its culmination in power probably about the sixteenth year.

Woodworth attributed inaccuracy in movement to (1) inaccuracy of perception, (2) inaccuracy due to the failure of the movement to obey our intention, (3) inaccuracy in the process of adjusting the movement to the perception. In regard to the first, it is a well-known fact that children when young see only the most characteristic or interesting thing about objects or drawings. They have not as yet the power to concentrate their attention on an object and analyze it into its parts, much less have they the power to analyze a written word into its elements and hold these in mind without straining and overtaxing the nervous system and ruining the eyesight. Little children five years

of age copying writing, perhaps from a distance, is a pitiable sight, and yet it is found nearly everywhere in current practice.

Writing requires the adjustment of a larger area of muscular and nervous tissues than any other movement of the body. It requires a steadiness not only of the hand, but of the whole body. Hancock tested the ability of children, aged 5-7 years, to stand still, and found that the girls in these two years gained in steadiness 32 or 33 per cent. of the power of control at five years of age, while the boys gained about 15 or 16 per cent. Curtis in his study of inhibition found that children from five to ten years of age were unable to sit still for more than one and one-half minutes at any one time, showing that the higher centers of voluntary control are not developed in any great degree until a late period of child life.

Besides the central unsteadiness, there is also a peripheral unsteadiness consisting of numerous small vibrations in the peripheral muscles involved in the adjustment for fine movements. As the higher centers develop, these movements tend to disappear. These movements will be treated at greater length under the subject of diffusion.

Since writing involves very complex and finely co-ordinated movements, requiring control of the fingers, hand, and arm, the child is not physiologically fitted to learn to write until the ninth or tenth year at least. Even then it is a question whether writing ought to be undertaken unless the hand has been trained through drawing, manual training, etc., and a steadiness of attention and sureness of eye developed. The practical rule would be to begin with work that involved larger movements and co-ordinations, and gradually work down to the finer and more complex. It must be very evident to all who think that the very complex movements and close attention required

in writing should not come first in the child's school life, but be postponed until he has gained some control over himself. It must be remembered that the fingers are the last part of the child's body to fully mature, and hence he has little control over them. This is the reason why little children appear careless many times, dropping pencils, making wrong lines in drawings and writing, etc.

The answer to the question, when does a child need to learn to write? may be summed up briefly in a few statements. Formerly writing was taught to fix the associations in reading, but since the idea has come in that it is much better not to urge the child to see each letter, or part, of the words read, but to be able to recognize them quickly by their most striking characteristics there is no excuse to introduce writing along with the difficult process of learning to read. Writing does not need to be taught until the child begins to feel a desire to express himself in written language other than pictures, etc. Spelling and writing are both the tools of language, and ought to be taken up together at a later stage than that of learning to read.

METHOD: ANALYTIC OR SYNTHETIC?

The thing of first importance in teaching writing is the correct adaptation and careful repetition of the elements of the letters. If the forms are learned incorrectly, they later, through practice, become automatic in these ungainly shapes, and then it is almost impossible to change to the correct forms. Correctness is more important than rapidity in the first stages of learning to write. To attain this correctness Meumann thinks that the synthetic method is better than the analytic, because a long delay over the elements and a correct adaptation of them can be later guaranteed. By having the child form one letter at a time, the innervation of the mind is retarded. In later

life the child never needs to write letter by letter, but words as wholes, with as much totality of impulse for each as possible. This working toward a more and more complete innervation tendency should be one of the chief aims in teaching writing. Prof. Book found from his experiments with subjects learning to typewrite that learners are especially liable to settle down to a rate of work far below their highest possibilities, and that this low rate of speed tends to become habitual.

CONTROL PROCESSES.

Downey found in her experiments no evidence of a voluntary act of writing without a sensory cue of some sort. Woodworth endeavored to find what sensations are relied upon for the government of the extent of movement. He found that at ordinary speed an adult could write a single letter or short word as well with the eyes closed as with them open. If several words were written with the eyes closed, the alignment was lost, or some other constant error was evident. He concluded that when the speed is low enough to permit of fine secondary adjustment, then the eyes assisted very much in forming the letters just right. The eyes in ordinary writing keep track of where the writer is in the line, of the alignment, spacing, etc., but for the formation of the letters we come to depend mostly on muscular and tactile sensibilities. Woodworth thinks that when the extent of a movement is to be judged, the eyes do it when they are in use, but that the proper impulse to set the muscles into co-ordination is the work of the muscle-sense. This is true because in writing one does not look at the movement of the fingers, but always at the result, consequently there is no association between the visual sensations of the moving fingers and the right impulse to cause the muscles to co-ordinate in just the correct way. He concludes that in adult writing

the co-ordinating control is vested in the muscle-sensation, and the closer control necessary to make one letter just the exact height of another is left entirely to the eye.

There seems to be three stages in the complete mastery of writing: (1) The visual control, (2) muscle-sense control, (3) automatic stage, the initial impulse together with later unconscious adjustments furnishing the control. The first stage is when the child is learning to write and he is endeavoring to follow a copy, hence tries to imitate what is set before him. Baldwin found that at first his child watched his movements and paid no attention to the result, but that later she connected the movements with the copy and then she directed her attention to the form. When the child attempts to imitate a copy, it does so in a halting, uncertain way, analyzing the form slowly, remembering one stroke or separate letter at a time. This is true even when the child is requested to write words in sentences. To make each stroke he will make many random movements, and from these choose the successful ones, or the ones giving the correct result, hence in the work of young children there are to be found many corrections. Adult introspection, Woodworth says, very rarely reveals an anticipatory visual verbal image, yet its value and use to children is obvious enough. The child has no muscle-sensations, either kinæsthetic or tactile, stored up in his memory upon which he can rely, these only resulting from successful practice. Concerning this Dr. McDougall writes:

"The possibility of linking muscular reactions in a system of harmonious and purposeful movements depends upon the incoming stream of sensations which these reactions themselves arouse. The control of each successive movement which is to take place is conditioned upon the sensing of the adjustment which has just occurred. The

moment this system of resident sensations is eliminated the reactions fall back into the primitive chaos which is exhibited in the impulsive movements of the infant, unless, indeed, they be directed in some secondary fashion, as by the sense of sight" (6, p. 242).

Meumann found that in the writings of children there was no one maximum pressure in a word or part of a word as is the case in adult writing, but that every stroke or letter was made with equal pressure, showing that there was no totality of impulse in the writing of words. Hence, the child must of necessity write haltingly, laboriously, irregularly, because of diffusion, and under a great strain throughout the whole body. Consequently little writing should be required when the child first begins, and that little should be acquired as unconsciously as possible, the emphasis almost from the start being not only on the form but on the thought represented by the form.

Fullerton and Cattell concluded that inaccuracies in drawing lines were due (1) to inaccuracy of perception and (2) failure of the movement to obey the subject's intention. To these Woodworth adds a third, namely, an inaccuracy in the intention itself, or in the process of adjusting the movement to the perception. In the case of a young child learning to write, the error due to each of these causes must of necessity be great because of his lack of power to concentrate his attention, to co-ordinate the necessary muscles, or to adjust his movement to what he with difficulty perceives. Poor eyesight, nervousness, writing material, external environment, health, temperature, emotion, etc., all influence the writing of children. As before quoted, Münsterberg thinks that it is quite likely that many of the unaccountable variations in accuracy result from more or less fleeting emotions. To expect perfect, uniform forms from young children is unjust.

The aim should be to get the form of the letters and then to encourage the child to write with more and more total will impulses, thus increasing the speed and lessening the strain.

When the child has practiced sufficiently he comes to depend less upon sight and more upon muscle-sensation, as now he has the correct ones to which he may refer. These have come to him through writing. Woodworth believes that a sensory kinæsthetic report on the movement as it proceeds is usually present in all acts of writing, even though it varies in different individuals. As a conscious control process this kinæsthetic report has great utility, usually acting as a corrective, but also at times as an initial process, or cue, as well. The hand-kinæsthetic process always accompanies writing as an act, but does not always enter into the consciousness of writing, since it may be in the form of an anticipatory image or a sensational report of the movement as achieved. Although the visual sensations never entirely drop out, yet as practice advances, the muscle-sensations control the movement in its intricate co-ordinations. Some adults never get beyond the visual control stage and they write haltingly all their lives, while the majority of people advance to the muscle-sensation control, and as a result write faster than the first class mentioned.

But there is still a third and final stage which may be termed the automatic stage. In this the person apparently writes without thought upon the form or movement, and with a very slight degree of consciousness of the act and result. The whole emphasis is thrown upon the thought of what is to be expressed. The impulse to write is made, or the movement is touched off, as it were, and the later adjustments are made unconsciously. As the writer thinks, his thoughts are immediately and unconsciously transcribed. By reducing what was at first a conscious

process acquired through the higher centers of the nervous system to a reflex or automatic process almost unconsciously controlled by the spinal nerve centers, the writer is in reality furnished with more brain power with which to carry on his higher thinking. Let the reader take a pencil and write his name quickly, and then write it a second time omitting a letter. Which writing required the more time and thought? Poor spellers and beginners in writing have their attention constantly directed to the form. All processes, such as writing and spelling, that can be made automatic should be made so as early as possible. Woodworth found that the automatic movement gained slightly in uniformity as the speed increased.

MOVEMENT.

After experimenting and observing, Woodworth came to the conclusion that for uniformity of slant, accuracy and speed, the forearm movement is by far the best of all the movements used in writing. This movement is to be aimed at, but let us now consider the young child as he begins the work of writing. His movements are jerky, cramped, excessive and uncertain; in other words, unorganized and uncontrolled. Out of these excessive and unorganized movements the later easy, fluent writing movement must be developed. When the child endeavors to use unpracticed muscles his movements are diffused; that is, the untrained movements are too much spread out. The right muscles do not contract at the right time and the whole movement is scattered because of the unorganized state of the brain. There is one thing that is very fortunate about diffuse movements and that is that without them there could be no individuality developed in handwriting, for if every sort of movement were fully provided for in the brain by heredity, then the child would simply go ahead in a prescribed way.

There is a false notion that the large muscles develop before the finer ones. The fact is that the finer muscles are in full operation early in life, but the ability to control these through the nervous system is not as great as the control over the more fundamental muscles. These finer muscles are the ones most easily stimulated and called into action in diffuse movements, and the most easily tired. Bryan found that in boys and girls of six the finger had acquired a smaller percentage of its ability at 16 years of age than any of the other parts. In the first years children do all the writing they do with the fine finger muscles because of diffusion, but the fingers get cramped and they must be carried across the page. When the child makes these additional arm movements, they are made not as well co-ordinated additions to the movements made by the fingers, but as separate clumsy movements that interrupted the finger movements, i. e., the child writes with his fingers until he can write no more, and then he stops the movement entirely and carries his hand across the page to another place. When the finger writing goes on, the hand and arm and other parts of the body through diffusion of stimulation are kept tense and ready to move.

Since diffusion tends to emphasize the small muscles, then teaching ought to emphasize the use of the large ones, and it is for this reason that some teachers begin the teaching of writing by having the children use the larger movements at the blackboard. Even then the child, because of diffusion, grasps the crayon too tightly. In addition to this work, large arm exercises ought to be given. As soon as the drawing stage of writing is past and the child does not need to go on so slowly any longer, then he should be hastened, and thus the co-operation of arm, finger and hand movements will be advanced. The

first results will be scrawls, but the child must somehow work out the complete co-ordination of his movements since speed as well as beauty of form are the aims to be kept constantly in mind when teaching writing. The rapid writing makes separate action of the finger movements, hand movements and arm movements, less convenient than the co-operation of these. Even young children should not be allowed to draw letter forms with the fingers long after the forms are in mind, but before the fifth grade at least, pupils should have acquired some fluency of the forearm movement.

SLANT.

In his experiments in movements used in writing, McAllister found that the natural slant is the most rapid and legible, and that the greater the slant to the right, the more rapid will be the writing; a slant of about 75° permits legible writing, but as the angle decreases below 70° the legibility rapidly decreases. (See Fig. p. 76). He also found that the hand acquires a slope farther removed from the perpendicular, usually, than the copy. For example, if the copy is vertical, the child will usually deviate 10° from the vertical.

These results will suffice to show that a vertical hand is not a natural one for the child nor the swiftest, consequently when he leaves school and is compelled to write fast, he is unable to keep on writing vertically, but writes a miserable, uneven slant. This is due to the fact that a new set of co-ordinated movements are brought into play and the old ones have to be broken up. Hence there is but one correct slope, psychologically, and that is the natural, or between 80° and 70°. If the slope of the copy is 85°, then the child will write with more of a slant to the right, perhaps 80°; hence the model should be of such a slope that even though the child naturally deviates 10°

from the vertical, yet by following the copy he will be led to write with a slant that is most conducive to legibility and speed.

The movement of pronation, discussed in the last chapter, affects all the possible corrections of slope, since by means of it the pen is kept more nearly parallel to its first movements at the beginning of the line. The movement of pronation is difficult to acquire perfectly, consequently the writing of children must of necessity be irregular in slope, especially at the beginning and end of each line. In order to secure uniformity, whatever the slope, pronation as a corrective movement must be used.

CONNECTING LETTERS.

McAllister concluded from his experiments that forearm movements in a horizontal plane were made with more rapidity toward the body than away from it, hence the up strokes in writing take more time than the down strokes. It is well that this is so, for when the child is connecting the letters in a word and slowly moves his hand in producing the up strokes, the eye has time to estimate the distance, consequently the letters are kept more even. Hence at first it is desirable to have the child connect the letters in a word even though later it is better to allow some of these connections to be dropped out, for without these guiding lines the letters formed by a beginner will be raised from the base line and the writing as a result be very confusing and irregular.

PRESSURE.

In all adult writing the pen is lifted many times from the paper during the writing of words. It is well that this is so since it is a great strain on the fingers, hand, and arm to try to write with a constant pressure on the paper for all strokes. When the pen or pencil is removed from the

paper the strain is absent. In addition to this, the omission of the up strokes and only making the characteristic ones adds much to the speed, since the up strokes take more time. The writings of adults show many omissions caused by the raising of the pen or pencil, e. g., examine your own writing. Meumann found that men usually wrote with a totality of impulse and a maximum of pressure for each word, with other weaker pressures subordinate to the maximum, while women wrote with less totality of impulse and with more than one maximum pressure in a word usually. This uneven pressure serves to relieve the strain, hence children should be trained toward this totality of will impulse from the beginning, not only for the sake of speed, but also to secure greater ease in writing.

VALUE OF LINES.

Woodworth and Judd both found that visual control was of value to keep the writing on the line or in other words to preserve the alignment. Lines other than the base line on the paper upon which children write are worse than useless; they are positively injurious to movement and a hindrance to speed. The child using them creeps along in his writing and very laboriously tries to make the top of the letters touch the appropriate lines. All this is not only a strain on his eyesight and the fine muscles of the fingers, but it hinders the child from getting past the drawing stage in writing and launching out into a movement involving the larger muscles, thereby coming into possession of the muscle-sense control. Without this free, larger movement the tactile and kinæsthetic sense control can never be developed to any great extent.

SPEED.

As has already been stated, the forearm movement is the one affording the greatest speed, and the natural

slant is the slope which allows the most rapid writing. McAllister found that the up strokes took more time than the down strokes, hence lifting the pen hastened writing and relieved the strain. Woodworth in his experiments found that there is a limit beyond which an increase in speed does not produce much greater inaccuracy, because then it is no longer possible to control the movements separately, hence much has to be left to the automatic uniformity of the hand's movements.

PRACTICE.

Since the acquirement of writing is such a complex, difficult process and one that takes time and practice to enable the child to gain muscle-sensation control, to possess himself of a system of resident sensations which will sense the adjustments as they take place and control thereby each successive movement, a careful consideration of the best means of practice is important. Woodworth concluded that the accuracy of the original impulse is slight compared with the additions made by later adjustments, when situations are presented which permit of great accuracy.

Practice for practice sake soon degenerates into carelessness and becomes very tiresome; as is clearly demonstrated in copybook work where each added line below tends to become more and more unlike the copy above, and to show greater and greater carelessness. In copybook work the emphasis tends to be upon the visual control because the teacher insists that the product resulting from the movements shall be as nearly like the model as possible. A copybook may be profitably used as a corrective of form, as a dictionary is the standard consulted when one is in doubt about the spelling of words, but a child who writes in copybooks chiefly during his earlier years

will never become through such practice a rapid writer using an easy, free movement.

The best form of practice is the life form, or the expressing of one's own thoughts in writing while thinking. Of necessity the child must know the forms, but as soon as he has a slight knowledge of these, he should begin to write his own thoughts, for in so doing the emphasis is placed upon the thought to be expressed and as a result the kinæsthetic and tactile sensations learn to take care of the writing act. This is the ultimate aim in the teaching of writing and the one that ought to be kept constantly in mind as the goal towards which all practice ought to tend. Original composition should be constantly required, for through this work the child will be trained to write the product of his thinking with the greatest amount of ease, rapidity, and legibility.

Copybooks can profitably be used as reference books in which to look up the correct forms of some of the letters incorrectly written by some children in their composition work, or they may be used for a review of form work in penmanship. For this last use it is wiser to have the pupils observe the correct forms of the troublesome letters, and then write these letters a number of times, after which the entire copy may be written perhaps once. When this is done, a comparison of the results with the model should be made by each pupil, after which with these differences in mind he should try again. Better far is a little thoughtful practice on the form in which each child is his own critic than hours and hours of careless work; only successful practice counts, because unsuccessful practice fixes wrong co-ordinations, and these are only overcome or broken down after long and strenuous effort. The whole copybook may be gone through in some such thoughtful manner as has been indicated above, writing only a few

lines each time, and then later writing through the book again, a few lines each time, to show all the improvement possible. From experimenting in actual school work it has been found that the best results are obtained in writing by having the writing the expression of thought, once the initial stage of learning has been passed, and then use the copy book as a reference and for corrective work when needed most.

LAW OF SHORT EXERCISES.

Johnson found in his experiments that after the drawing of the third circle the subjects began to make inaccuracies. He concluded that when practice is continued until the movement becomes irregular, then the practice becomes positively injurious for the reason that the irregular movements become incorporated in the chain of reaction as surely as do the well-directed ones. Practice may thus tend to establish irregular adjustments as well as regular ones. If wrong adjustments are made, then these delay the development of the control over the muscles for accurate adjustment. Woodworth concluded that only successful practice counted. This means in actual practice that long writing periods, during which the child is allowed to dwaddle along in an inaccurate fashion, are worse than none at all; in other words, profitable practice periods in writing should be short. A number of short periods with intervals of rest or change of work are much more beneficial than an equal amount of time in one long practice period.

STANDARD FOR JUDGING WRITING.

What standard should guide the teacher when judging the handwriting of pupils? The world's standard is that the writing shall be legible, and that the writer shall be able to write quickly and easily. Most teachers are in the

habit of judging of a child's writing whether it be good or bad by the approximation to or the difference from the set copy; that is, the child is expected to make every letter according to the copybook style, size, slant, etc.

Johnson found in his experiment in which he had the subjects draw circles from copies that some of the subjects increased while others decreased the size of the successive circles drawn, and from this concluded that each individual has a certain adjustment of the muscles in writing and drawing which should be taken into consideration when training the muscles for accurate adjustment. From observation it is easy to see that each individual almost has his own peculiar style and size of handwriting. Preyer classed all writing as being either natural or artificial, and under the head of artificial he placed the writing of children. In the very first stages the child's writing must of necessity be artificial, as a copy, the teacher's writing, is imitated; but if the child is allowed freedom of choice in the matter, his writing will more and more approach the natural. So much individuality is shown in handwriting that graphology has come to be an established study, and many books on the subject have been published. One author writes: "Every act of a man's life bears the stamp of his personality . . . The timid person who gives you a weak, fishy handshake writes a timid, weak hand, and the virile man who grasps you firmly writes a firm, decided hand. Vivacious persons do not produce nerveless scrawls, neither do lethargic persons wield nimble pens" (36, p. 3). If the child is compelled to write artificially, following calligraphic instruction so closely that individual characteristics almost vanish, the chances are that he may never write naturally, forming the letters and joining them in an entirely individual way. In all correspondence we instinctively judge one another by handwriting. We com-

ment upon its legibility or clearness, its tidiness or slovenliness, and form our opinion of the writer accordingly.

A recent extremely significant and valuable contribution has been made to educational psychology by Dr. E. L. Thorndike of Columbia University in the presentation of his scale of handwriting, by means of which the quality of a sample of penmanship may be measured. It is the first attempt of its kind and its application ought to appeal to every teacher of writing. Although Dr. Thorndike has not completed the scale to his entire satisfaction, yet he has made his results public and hopes in time to bring them to a high stage of perfection. He has very kindly consented to allow his scale to be reproduced in the present work and has suggested the samples of quality of most practical value to teachers, and these, he thinks, would give a clearer idea than his more elaborate series.*

The scale was constructed by having from twenty-three to fifty-five competent judges rank, say 1000, samples of children's writing selected from the best to the worst handwriting found in grades 5 to 8. In trying to rank 1000 samples in order of merit, the judges found that they could not make 1000 such ranks, since some of the handwritings were indistinguishable in "goodness" or "quality" or "merit." Neither could 100 such ranks be made, nor 40, but only about 20. The judges found that even when they made 20 ranks of the samples a number of times, they got substantially the same average results as when they ranked them a number of times in 10 or 11 groups. To get an individual's judgment of the relative merits of the 1000 samples it is sufficient to have him rank them into 10 or 11 groups three or four times. If he grades in ten groups and tries to make the differences all equal, we have in the average results (except for certain factors which Dr.

*Thorndike, Edward L. Handwriting, Teachers' College Record, March, 1910. Columbia University Press, New York city.

Specimens of Quality selected and reproduced by permission from *Teachers College Record*, Vol. XI, No. 2.

HANDWRITING, by Edward L. Thorndike.

Quality 17—Sample 141.

Then the carelessly dressed gentleman, stepped lightly into Warren's carriage and held out a small card, John vanished be-

Quality 15—Sample 49.

lightly into Warren's carriage and held out a small card, John vanished behind the bushes and the carriage moved along down the drive

Quality 15—Sample 89.

held out a small card, John vanished behind
the bushes and the carriage moved along
down the driveway The audience of passers-

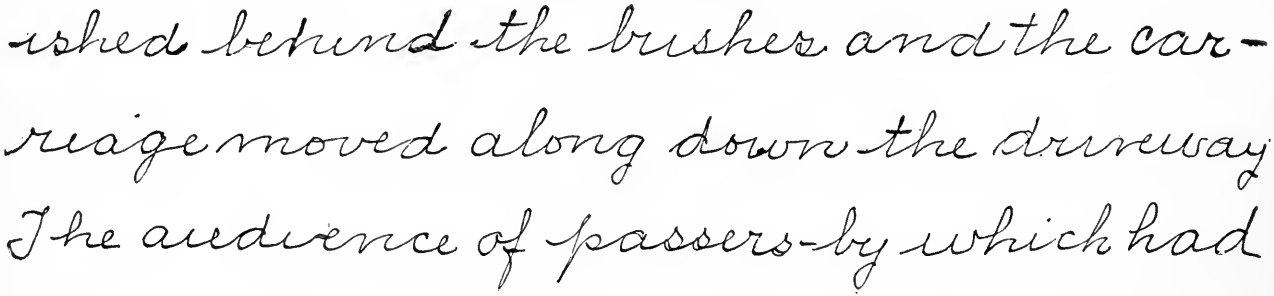
Quality 15—Sample 90.

John vanished behind the bushes
and the carriage moved along
down the driveway. The audience

Quality 13—Sample 55.

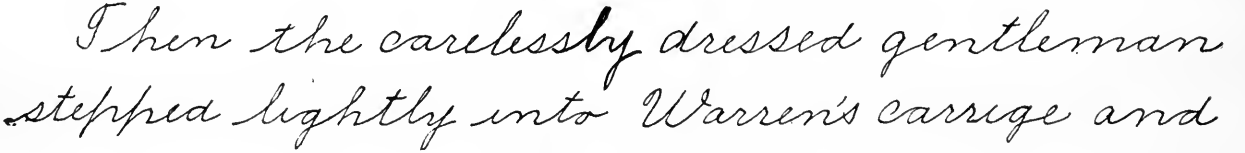
Then the carelessly dressed gentleman stepped
lightly into Warren's carriage and held out a

Quality 13—Sample 24.



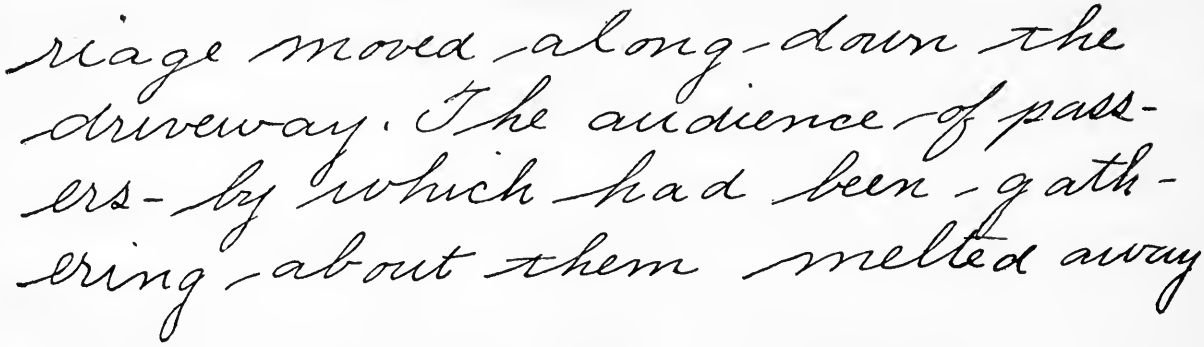
-ished behind the bushes and the car-
riage moved along down the driveway.
The audience of passers-by which had

Quality 13—Sample 26.

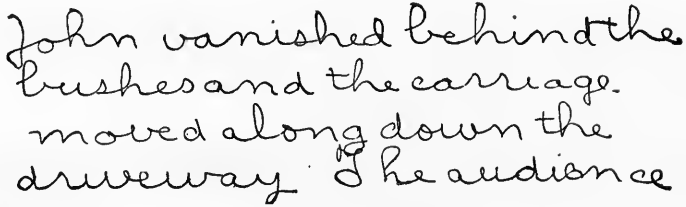


Then the carelessly dressed gentleman
stepped lightly into Warren's carrige and

Quality 11—Sample 23.



Quality 11—Sample 106.



Quality 9—Sample 31.

Then the carelessly dressed gentlemen
stepped lightly into Warren's carriage and
held out a small card, John vanished behind the

Quality 9—Sample 21.

by which had been gathering about them melt-
ed away in an instant leaving only a poor
old lady on the curb. Albert was sadly

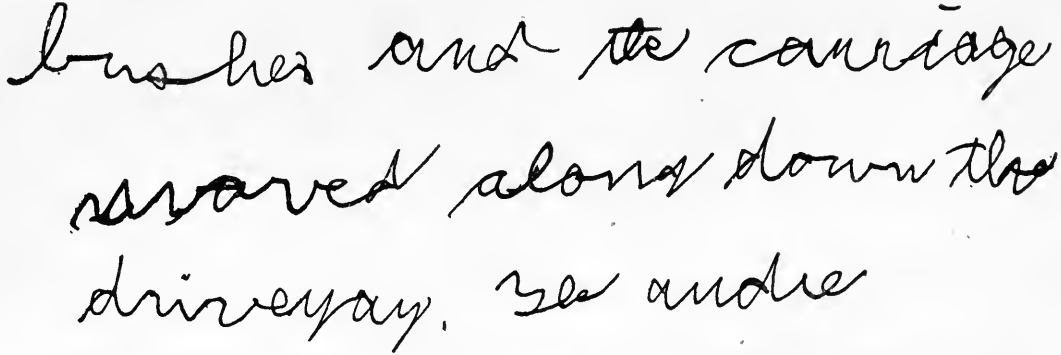
Quality 9—Sample 28.

Then the carelessly dressed gentleman stepped lightly into. Warren's carriage moved and held out a small card, John vanished

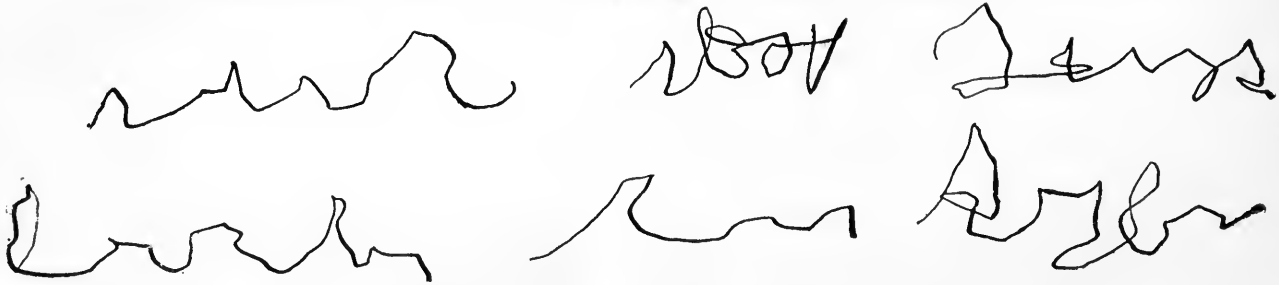
Quality 7—Sample 126.

card, John vanished behind the bushes and the carriage moved

Quality 5—Sample 6.



Sample 140, representing zero merit in handwriting. Zero merit is arbitrarily defined as that of a handwriting, recognizable as such, but yet not legible at all and possessed of no beauty.



Thorndike explains fully in section 7 of his work) of his grouping his judgment of the relative merits of the samples in a specially convenient form.

SCALE A (As suggested).—A Scale for Handwriting of Children in Grades 5-8.

The unit of the original scale equals approximately one-tenth of the difference between the best and worst of the formal writings of 1000 children in grades 5-8. The differences 16-15, 15-14, 14-13, etc., represent equal fractions of the combined mental scale of merit of from 23-55 competent judges.

Sample 140 represents zero merit in handwriting. Zero merit is arbitrarily defined as that of a handwriting, recognizable as such, but yet not legible at all and possessed of no beauty.

In the original scale the use of 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 for these qualities of handwriting means that 11 is as much better than 10 as 10 is than 9, and also that 14 is twice as far above 0 merit in handwriting as quality 7 is. The use of several samples under one quality means that those samples are of equal merit. As many different styles as could be obtained are shown, so that in using the scale the merit of any sample of any style of writing can be readily ascertained by comparison with the scale. Quality 5 represents the worst writing of fourth grade children, quality 7 is nearly the worst writing of fifth grade children, while quality 17 is nearly the best writing of eighth grade children.

To measure a specimen of handwriting, put it alongside the scale, and see to what point on the scale it is nearest. For convenience the entire scale should be in view when the sample is to be examined. The measurer should be careful not to decide the grade because of likeness in style, but only because of likeness in quality. If,

for instance, a pronounced vertical sample is really of quality 7, one must not call it quality 9 because it is in style more like sample 21 than like the sample of quality 7. Observers using the scale will disagree as to the merit of a sample of handwriting. This is not the fault of the scale, for without it the observers will differ still more widely. Two people will not find a given line to be exactly the same, and yet they will agree better than if they had no scale to use. At present we can do no better than estimate a handwriting as very bad, bad, good, very good, or extremely good, knowing only vaguely what we mean by these terms, running the risk of shifting our standards with time, and only by chance meaning the same by a word as some other student of the facts means by it. As Dr. Thorndike says, we are in the condition in which students of temperature were before the discovery of the thermometer or any other scale for measuring temperature beyond the very hot, hot, warm, lukewarm, and the like, of subjective opinion. It is to be hoped that this graphometer or scale for handwriting may be of practical value to every teacher of writing.

The scale has many uses, only a few given by the originator of the scale will be noted. Any measurement of the quality of handwriting may be made more accurately and conveniently with the scale, either actually present or held in memory, than without it.

The class-room teacher has to measure the quality of a single pupil's handwriting in order to assign him a rating in comparison with his fellows and, better still, in comparison with his past work. She can use the scale by giving its numerical measures outright or by letting her A, B, C's, or 75, 80, 82, etc., per cents, or excellents, goods, fairs, etc., mean certain points on the scale. If she does this, her ratings will have a definite meaning to the pupil, the same meanings that similar ratings by other teachers in the school have, and thus may be used to measure the actual

improvement of the pupil month by month and year by year.

A superintendent of schools, principal or supervisor needs to measure the quality of the handwriting of individuals, of classes, of all classes of the same grade in a school or system. With the scale he can honestly measure and compare the work of one teacher with that of another, the work within his own school or system with that of other schools or systems and with that of his own some years later. A supervisor can inform his teachers of, say, grade 7, that the minimum requirement is, perhaps, quality 11, at a rate of 50 letters per minute. The business men can decide what quality they desire the schools to secure in the fourteen-year-old boy who is to apply for clerical positions.

Even pupils themselves may profitably know and use the scale. They may see by it what is expected of them, and may tell how nearly they reach the standard and how much they have gained.

RELATION OF WRITING TO SCHOOL INTELLIGENCE AND SEX.

After examining 12,600 specimens of papers written by the pupils in the public schools of Worcester, Mass., Gesell came to the conclusion that for a large number of cases accuracy in the writing of pupils of elementary grades tends to vary directly with school intelligence. Carelessness in any motor function seems to bespeak the same qualities in the general school work of children in the elementary school. Kavanagh found the lowest correlation between handwriting and other abilities, as compared with other subjects. These experiments are sufficient to show that writing depends upon the development of higher centers, upon quickness and sureness of action, upon the power to concentrate attention, etc.

From the fifth grade up through the high school, Gesell found that girls as a class write more accurately than boys, boys as early as the first grade showing a greater degree of inco-ordination in writing. The sex difference in writing seems to become marked about the age of ten and is largely attributable to the mental factors; hence in teaching, those differences need to be considered. Meumann found that men tended to write with a totality of impulse and with a maximum pressure in a word, while women were more painstaking and wrote with several maxima pressures in a word. With an increase in speed, the pressure was greater in the case of men and lighter with women. In school, boys need to be encouraged to be more careful and accurate, while girls need to be urged to attempt larger will impulses and to secure thereby a larger, freer movement.

RIGHT AND LEFT-HANDEDNESS.

There have been many theories as to the reason why most people are right-handed and some few left-handed, but here only the most generally accepted one will be mentioned. It is now quite generally believed by psychologists that a person is right or left-handed according to the manner of the branching of the arteries carrying the supply of blood to the brain. If the larger supply of blood is sent to the left half of the brain, then the person is right-handed, and vice versa. As a result, the speech center is more fully developed in the third left frontal convolution for the dextral than in the opposite side of the brain (20, p. 364). This developed center controls the actions of the right hand. There seems to be a close relation between the speech and writing centers, as the latter is developed in the same half of the brain as the former.

What then will a teacher do with a left-handed boy?

Ought she to try to force him to use his right hand? It has been found by investigation that left-handed children who have been made to learn to write with their right hands, never in later life reach the point where they can write with any degree of speed and ease. The location of the speech center that is so closely related to that of writing cannot be changed, hence it is much better not to try to make a naturally left-handed child write with his right hand, because it leads to confusion in thinking and lower ability in writing.

CROSS-EDUCATION.

The subject of cross-education is an extremely interesting one, attracting such psychologists as Scripture, Bryan, Davis, etc. These men all found that the effect of practice on one side of the body is transferred in some degree to the unpracticed side, the transference being greatest to symmetrical and closely related parts. There is a very close connection, Davis thinks, between different parts of the muscular system through nervous means, parts related in function or in position being more closely connected. He also concluded that will power and attention when developed for any special act are developed for all other acts. The effects of muscular practice seems to be central rather than peripheral. The two central effects seem to be (1) the development of motor centers, and (2) the development of attention and will power. That is, when a child is trained to write with the right hand, and the writing center with its sensory and motor sides is well developed and the child has the power of concentrating the attention upon any subject or act and the ability to will impulses in writing words or parts of words, then if he attempts for any reason to write with the left hand, he will find that he can do so fairly well. All that is needed

in such a case is practice in manipulating the left hand. If one will but try to write with his left hand, he will be surprised to see how well it can be done, even though it be the first trial.

Since this is true it must be self-evident to all that it is a waste of time and a detriment to the child for the teacher to endeavor to meet emergencies by training the child to write with each hand. It is much better for a child to be able to write automatically and legibly with one hand than fairly well with both. Some have claimed that for the sake of the symmetrical development of the child he should be made ambidextrous. The facts already discussed concerning the development of the speech center in the left side of the brain in right-handed people, and the intimate connection between this and the development of the writing center, go to show that if an attempt were made to make the child ambidextrous it would result in the disorganization of the speech center and lead to poor expression of thought. The localization of the speech center comes down through a long line of ancestry, and any training contrary to evolution is always more or less detrimental to the fullest development of the mental powers, hence no one should attempt to make a left-handed child right-handed, because of the peculiar organism of the child's brain.

RELATION OF WRITING AND SPELLING.

The necessity of having the act of writing as nearly automatic as possible, so that the mind may be centered upon the thought to be expressed is apparent to all. Writing has to be acquired with a more or less degree of consciousness, under the control of the higher centers, but the ultimate aim should be to relegate writing to the control of the spinal cord so that we may write as auto-

matically and unconsciously as we walk. In order to do this the attention must not be delayed or attracted by any doubt in regard to the spelling of any word, but the spelling itself must also be as automatic as walking. The automatic development of writing and spelling must go on together, each depending upon the other for advancement. The only way to bring this development about is to make the original composition work the test and basis of practice for both spelling and writing. Writing words in lists, where the thought is upon the form entirely, will never make the child entirely successful in the use of the same words in original composition where the mind must of necessity be upon the thought to be expressed. Dictation work, another step in advance of list spelling, in which the thought to be expressed is given to the child and he has only to hold the same in mind and to express it, will not lead to the automatic writing advocated, but serves as one of the legitimate and necessary steps by which this end may be attained. The only kind of practice in writing and spelling that will bring about automatic writing is to have the child think his own thoughts, as he will have to do in later life, and then express these in writing as rapidly and legibly as possible.

Most teachers think that when they have taught the forms in writing and given the child some ideas of correct movement and position, that their work is ended, but such is by no means the case, for the child has only begun to learn to write. It is the work of the teacher to see that the right kind of practice is carried on until the child has learned to put the least degree of consciousness into his writing act. In the same way teachers have thought that when a child was able to spell a word that then the work in spelling was done, and another word would be taken up, and so on; but words thus learned are soon forgotten.

The work of learning to spell has only just begun when the child is able to name and write the letters. It remains for him to learn, through practice in expressing his own thoughts, to be able to use the word in different contexts and to write it automatically. In order to do this much practice is necessary, and original thinking not only gives variety enough to keep up the interest and attention of the child, but above all, it is the form of writing required in after life. Both writing and spelling should ultimately be controlled by the lower neutral centers, leaving the higher centers free for thinking.

If teachers would only follow out these suggestions, there would be a happy and profitable revolution in the teaching of writing and spelling in our public schools; children would not only be relieved of the tedious, distasteful and harmful drill, causing them to dislike school and drop out as soon as the age limit is reached, but more efficient and powerful students would be graduated from our schools. Then the world's accusation that children do not know how to spell and write their mother tongue would no longer be so commonly heard and generally true.

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INDEX